AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 44 No. 2 **FEBRUARY 1954** PRICE: 3s. 6d.


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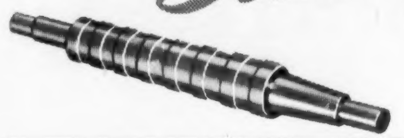
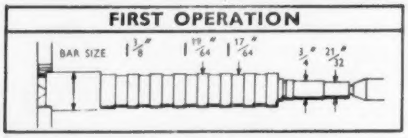
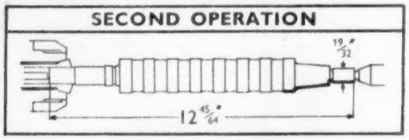


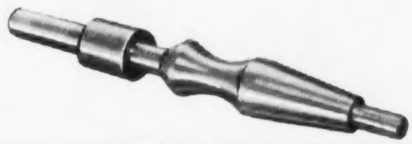


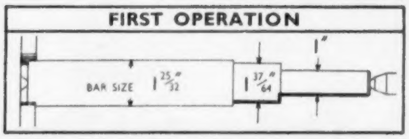


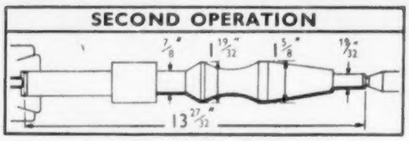
Material St 60. 11
First operation 138 secs.
Second operation 67 secs.
Total time

3 minutes 25 seconds

These lathes copy direct from a workpiece or from a 1:1 templet. Hydraulic power is applied to the feed and rapid return of the longitudinal slide. Parts with shoulders of 90°, tapers, concave or convex forms, etc., are produced in very fast times to a high degree of accuracy and with fine finish. Height of centres $4\frac{11}{16}''$. Available with distance between centres $15\frac{3}{4}''$ or $25\frac{5}{8}''$.







Material St 50. 11
First operation 137 secs.
Second operation 251 secs.
Total time

6 minutes 28 seconds

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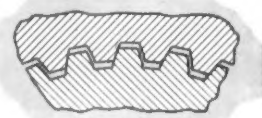
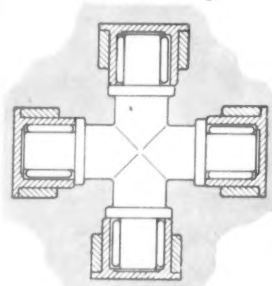
TRANSMISSION CONSIDERATIONS 6

BACKLASH

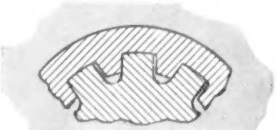
Clutch shaft splines



Direct drive dog

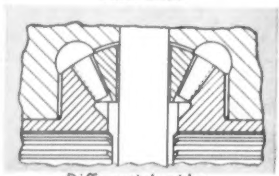


Universal joint

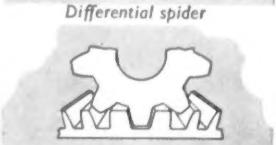


Propeller shaft sliding-joint splines

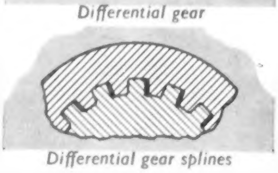
Final drive



Differential spider



Differential gear



Differential gear splines

This is a source of trouble that cannot be eliminated although it can be reduced by care in manufacture and design. For the most part, it arises for clearances which in some measure are inevitable at various places. Earlier in this series it was noted that these can aggravate judder and rattle. No further reference need be made to those aspects of the matter but there are other ways in which the same clearances can cause trouble.

By way of illustration, it will help to consider one effect of a freewheel. When these devices appeared in the transmission systems of numerous cars some 20 years ago, there were arguments as to whether or not they could cause shock when the drive was taken up. The simple view was that, at the instant when the freewheel re-engaged itself, its two shafts were revolving at the same speed and therefore no shock could occur. This was fallacious.

Such mechanisms vary considerably in detail but even the best of them require the driving member to over-run the driven member to some extent in order to lock these two parts together. This is obvious enough in the old pawl-and-ratchet bicycle freewheel. Perhaps less relative movement may serve the purpose in the wedging-roller type but relative motion there must be.

It follows that the driving member is revolving faster than the driven member when the freewheel locks. So there must be some shock at that moment.

This little exposition is in fact less of a diversion than it might seem. Freewheels figure in some of the most modern transmission systems and it is well to remember that they can cause shock loads.

Consider now a more conventional transmission with its normal share of clearances. As the vehicle comes to rest, most of the transmission usually is being turned by the road wheels. Various clearances are therefore all in one direction. When the clutch is engaged to restart, that end of the system must revolve through the sum of all those clearances before any resistance is offered by the road wheels. In short, appreciable shaft speed is attained before the system is under load. When the load is taken, therefore, there is likely to be some shock.

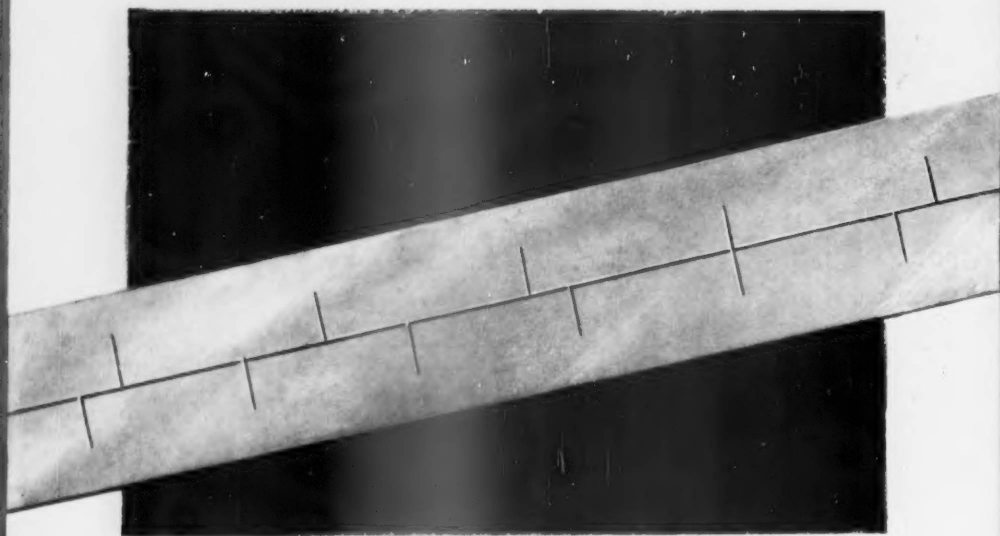
From what has been said, it will be realised that the magnitude of backlash shock when starting from rest depends largely upon the engine speed at the instant when the road wheel resistance is felt. This is governed to some extent by various features of the transmission system.

With each form of automatic transmission, a certain predetermined engine speed must occur before engagement commences. Even with a simple clutch entirely under the driver's control, there may be a big difference between a solid clutch plate and one that is so well cushioned that the various clearances can be taken up at tick-over speed before considerable torque is applied.

Backlash shock is not confined to the moment of starting from rest. It occurs also each time the throttle is closed and re-opened with the vehicle in motion and without any clutch manipulation. Traffic conditions and easy descents therefore give backlash many opportunities to hammer away at the transmission.

Broadly, it seems to be true that the higher the shaft speed, the greater the shock for a given amount of backlash. Generally, too, it is likely that the greatest impact will be felt at the point of maximum backlash but this is not always so. If there is much difference in the frictional effect between the various pairs of members, it is easy to see that a point of comparatively small backlash could be the last to take the drive and might thus receive the full impact. Experience suggests that in fact the half-shafts and the differential mechanism suffer the greatest shocks from this cause.

Similarly the more rapid the clutch engagement with dissimilar speeds, as between pressure plate and driven plate, the greater the shock.



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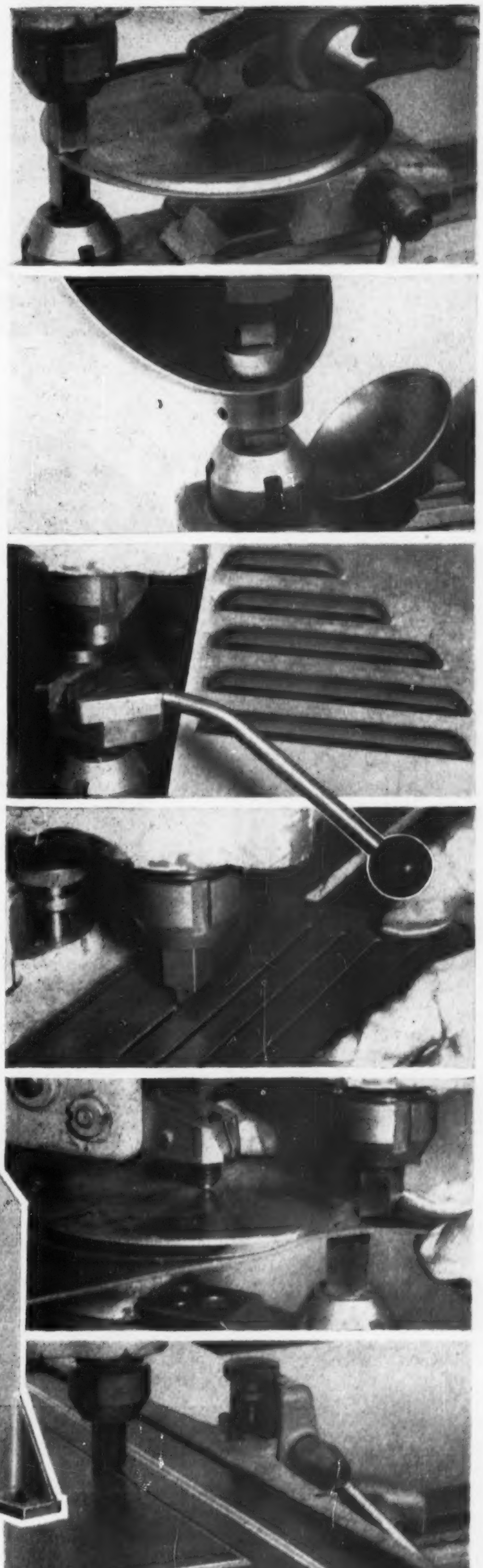

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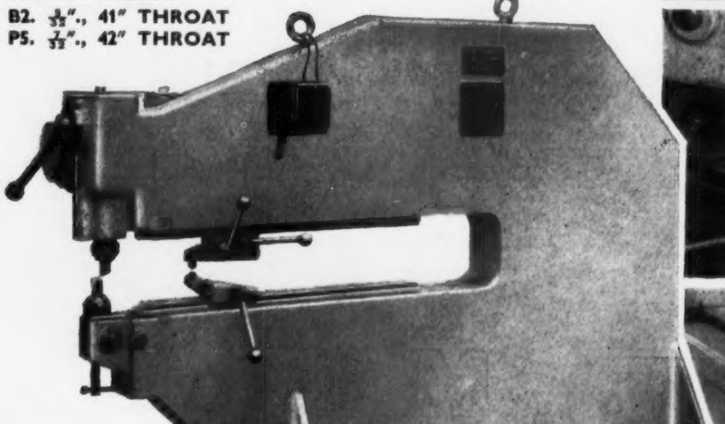

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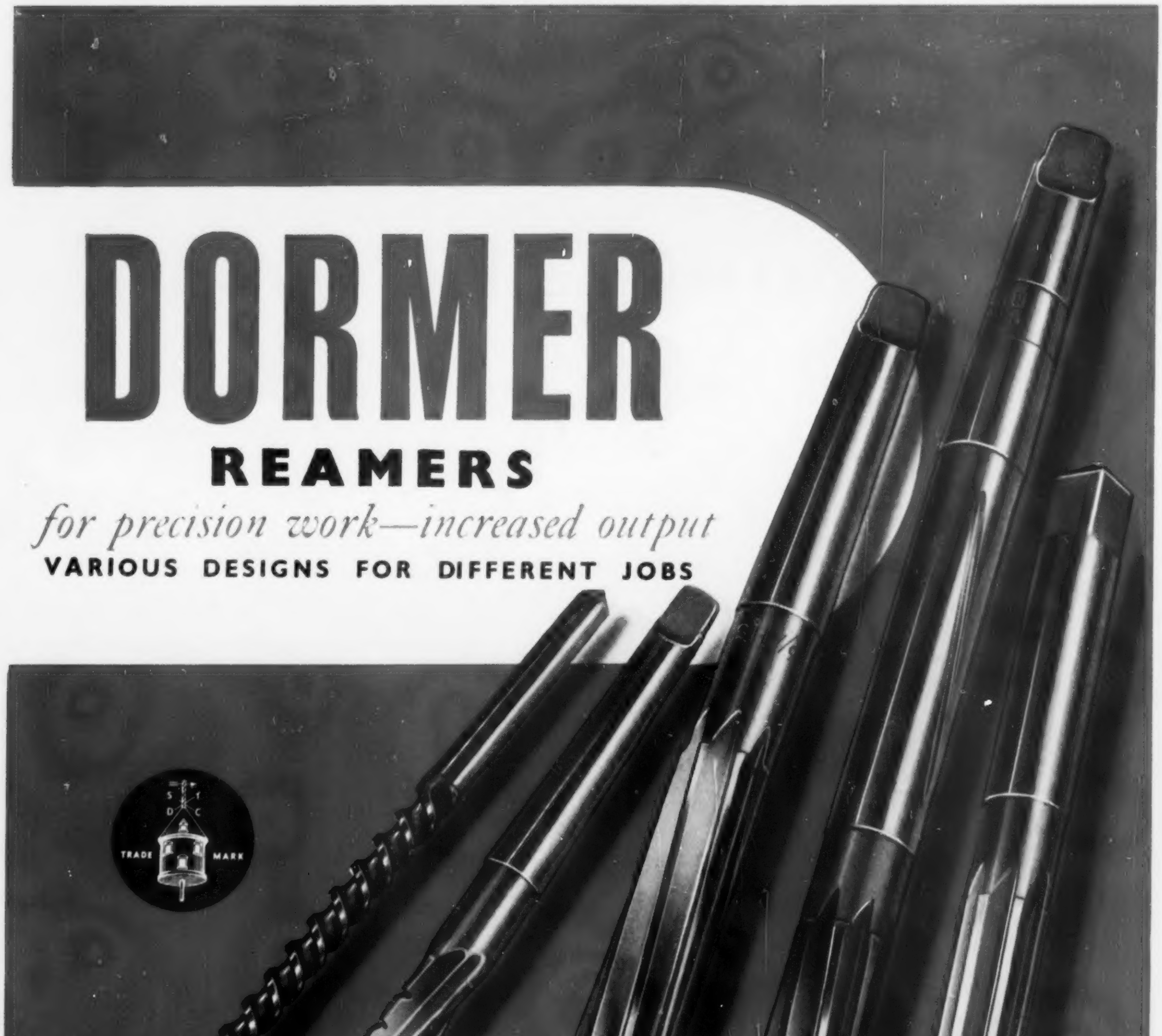

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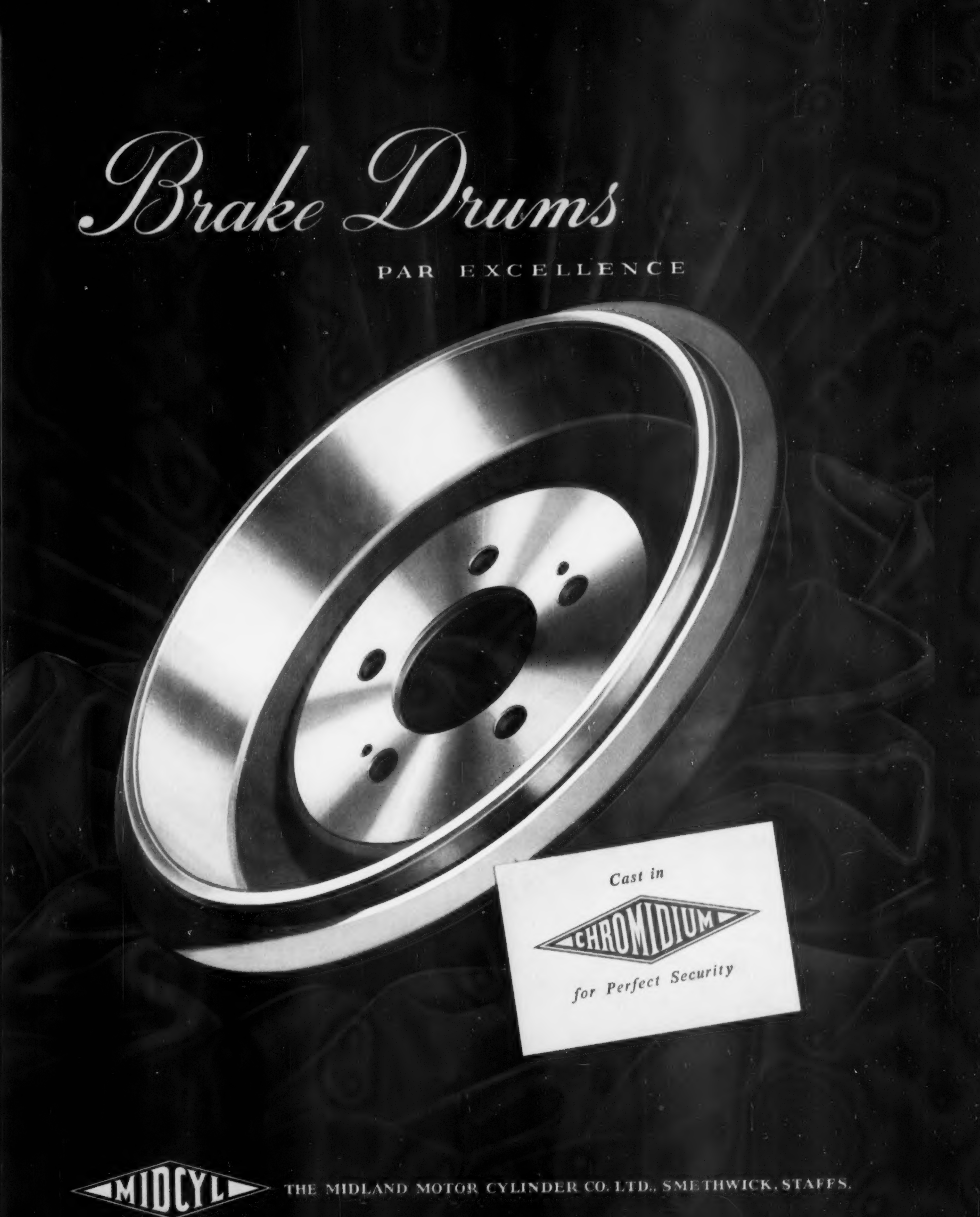
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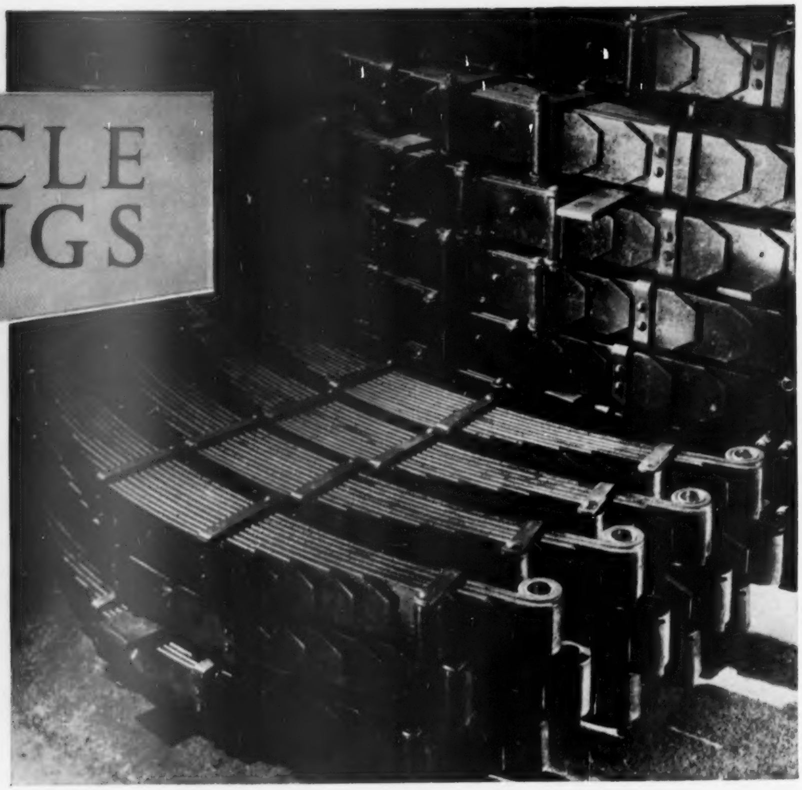

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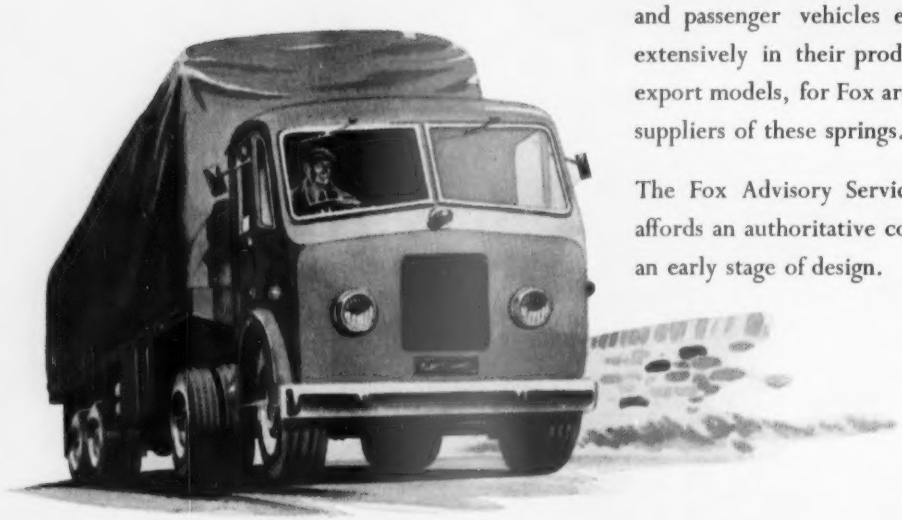

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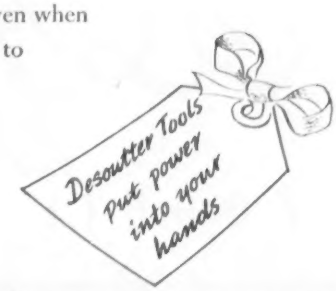

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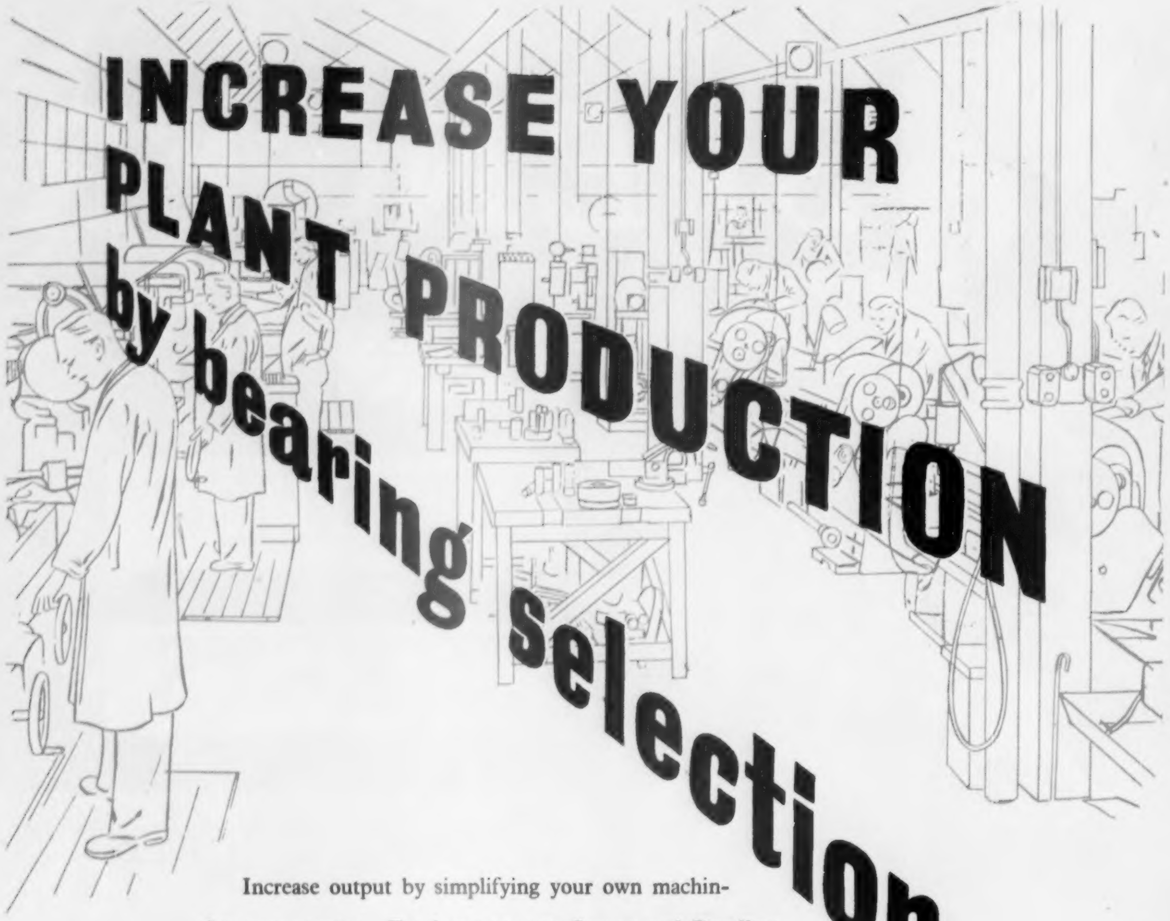

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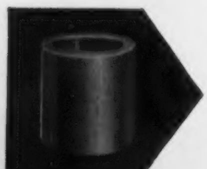

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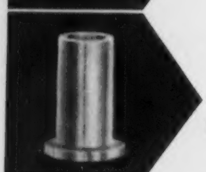

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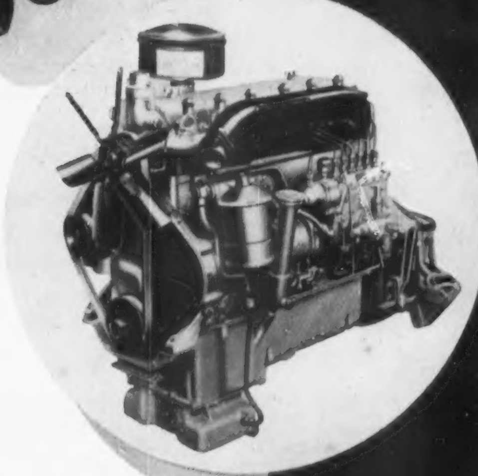
In circle, Perkins '6' on Austin 'Loadstar,' front and rear.



Bedford '0' series, front and rear mountings, shown in top and bottom photos.

In addition, Metalastik mountings are used on the Perkins diesels fitted by Dodge on their new 7-tonner, and on Chevrolet, Dennis, Guy, Jensen and Seddon.

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The small illustrations show some of the various types of Metalastik mountings used on the Perkins four and six-cylinder engines.

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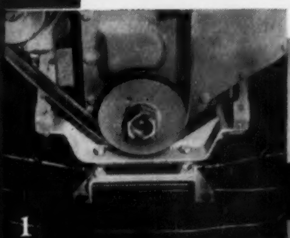
1. *Metalastik front mounting for Perkins diesel engine on Chevrolet.*
2. *Metalastik rear mounting for Bedford '0' series with Perkins diesel engine.*
3. *Metalastik 'Metacone' rear mounting for JNSN lightweight chassis with Perkins diesel engine.*
4. *Metalastik front mountings on the Dodge 7-tonner with Perkins R.6 diesel engine.*



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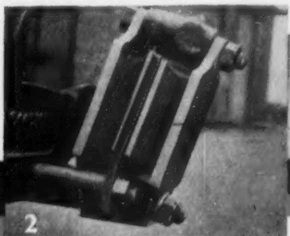

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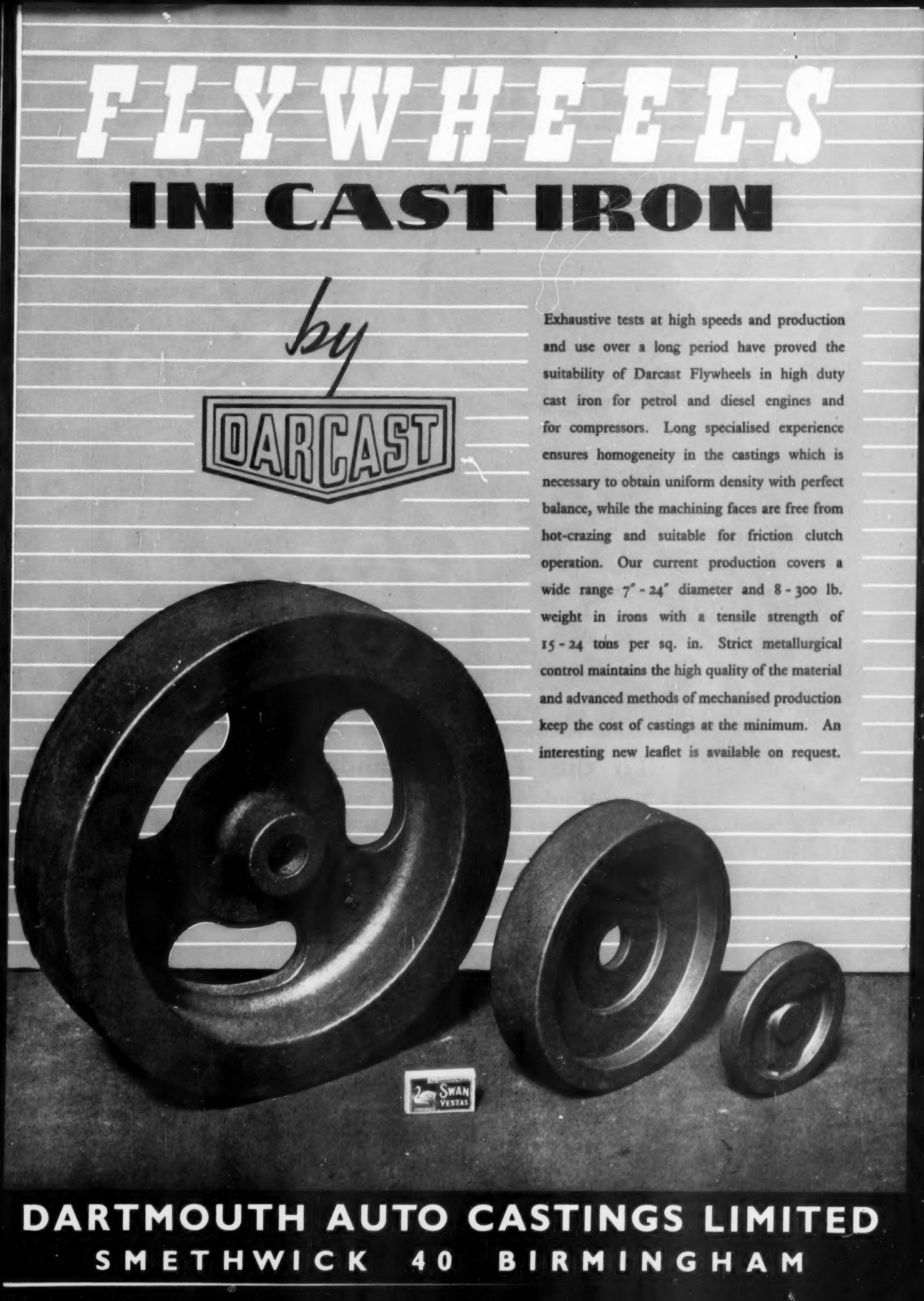
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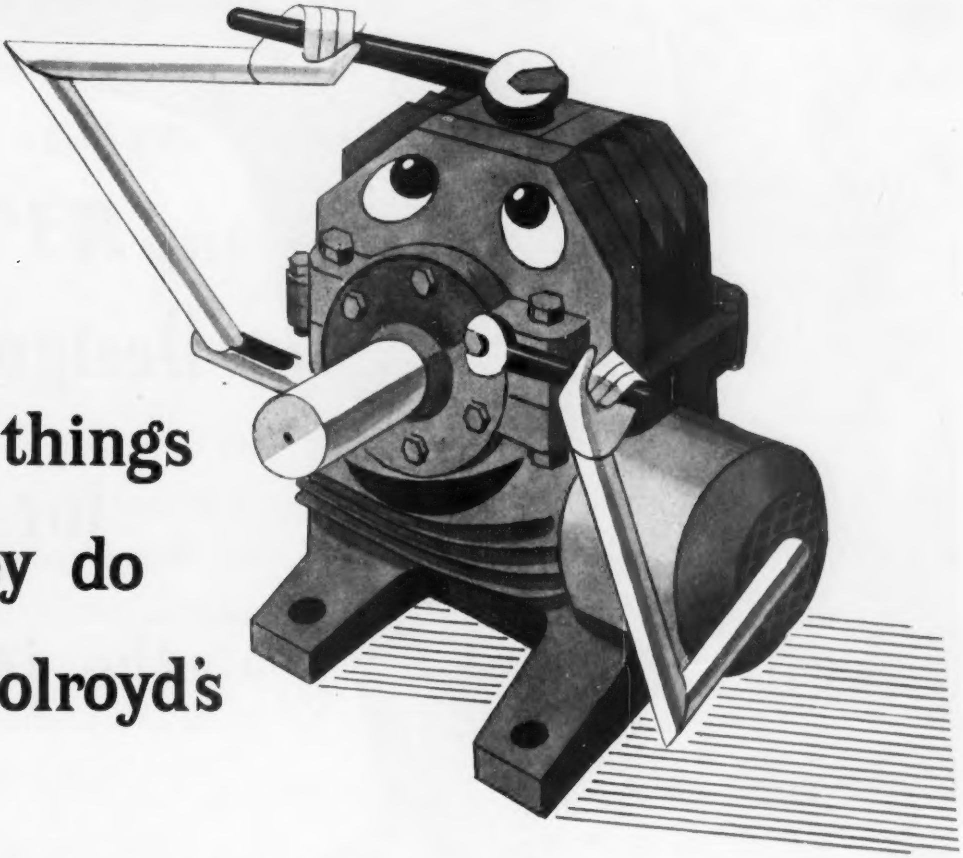

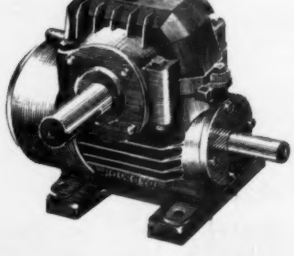

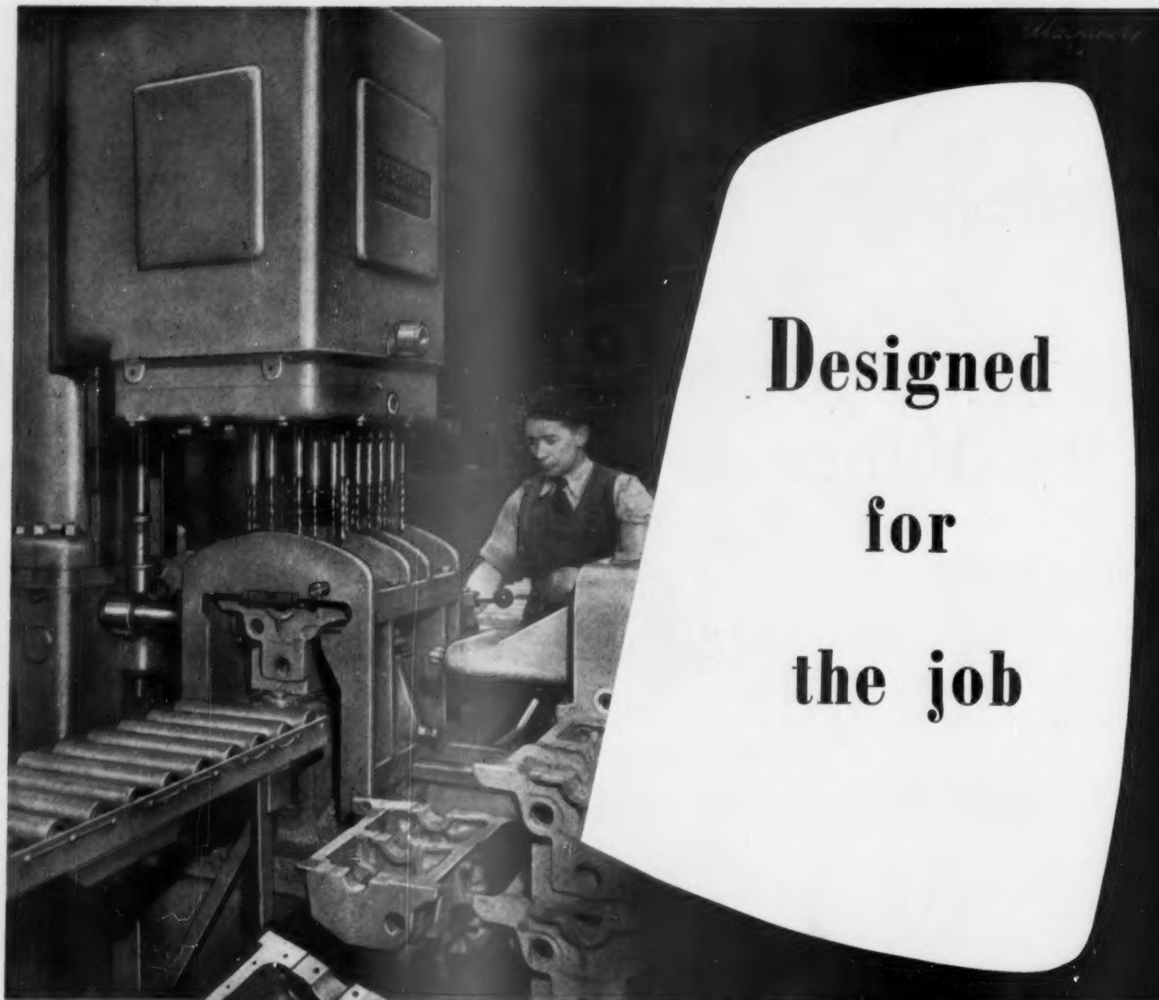

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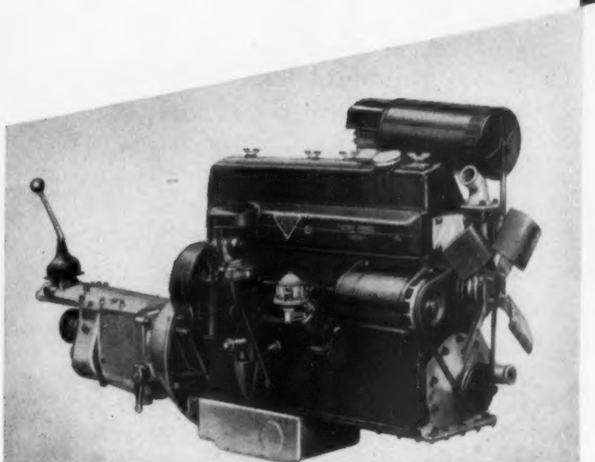

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efficiency
THE C.M.F. END LOCK SEAM
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The CMF
full-flow flat tube
radiator block
has superior heat dissipating qualities which have been so widely acknowledged that radiators built on this principle have been supplied by us in quantity to the leading manufacturers in the motor trade for many years. We have design experience and complete production facilities to undertake radiator contracts of any size - from the design stage to delivery, which will meet the closest schedules you may need to impose.
COVENTRY MOTOR FITTINGS CO. LTD.,
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CMF
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The four-high tinplate temper mills at
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for British Motor Cars
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Detachable oil filter

element easily inspected and replaced

This AC partial-flow oil filter with replaceable element meets the increasing demand for a filter that can be removed for inspection and replaced every 5/7,000 miles. It provides a permanent installation for coupling into the oil supply system and the filtering element can be replaced without disturbing pipe connections. Sump oil is filtered on an average of ten times an hour. This means less motor wear and longer motor life — the objective of every motor manufacturer. AC also manufacture a range of full-flow oil filters.

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Specify

BALL & ROLLER R&M BEARINGS

They save in the long run

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SINGLE ROW BALL JOURNAL BEARINGS

The three quarter sectioned view of a Single Row Ball Journal illustrates a bearing capable of withstanding journal load or combined journal and thrust loads (in either direction), and is therefore the most universal type of bearing employed.

THERE IS A BEARING FOR EVERY INDUSTRY'S NEED

- ★★ BALL JOURNALS
- ★ ROLLER JOURNALS
- ★ DOUBLE PURPOSE BEARINGS
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- ★ NEEDLE ROLLER BEARINGS
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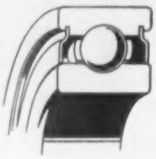
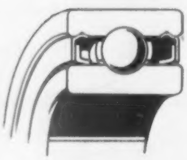
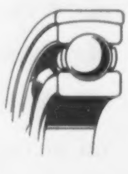


Amongst the variations to this design are the SHIELDED SERIES where metal shields are fitted to either one or both sides.



SEALED BEARINGS where either one or two synthetic rubber seals are fitted which retain the lubricant and exclude foreign matter.



SINGLE ROW SELF ALIGNING BEARINGS where the bearing is fitted to a spherical seating, are also available.

OUR ENGINEERING DEPARTMENT WILL WELCOME THE OPPORTUNITY TO CONSIDER YOUR SPECIFIC APPLICATIONS AND MAKE RECOMMENDATIONS.

RANSOME & MARLES BEARING CO., LTD., NEWARK-ON-TRENT, ENGLAND

K/RM113

Automatic SPOT WELDING with B.O.C Argonarc equipment

TRANSPORTABLE APPARATUS

- **Full fusion achieved by application to only one side of work**
- **Joins thin to thick sections**
- **No skill—No goggles—No screens**

The Argonarc Spot-Welding Process permits full fusion on sheet and thin plate with one-side-only access to the job. It makes possible fast, flux-free spot welding on stainless steels and tack welding in assembly work. It can also be used on bright mild steel and certain non-ferrous metals. The process will join thin to relatively thick sections.

The operating cycle is automatic, calling for no skill other than positioning the nozzle and working the trigger switch. Because the arc is screened by the torch nozzle, no goggles are needed and no inconvenience is caused to other people in the workshop.

Ask your NEAREST B.O.C BRANCH for full details


1
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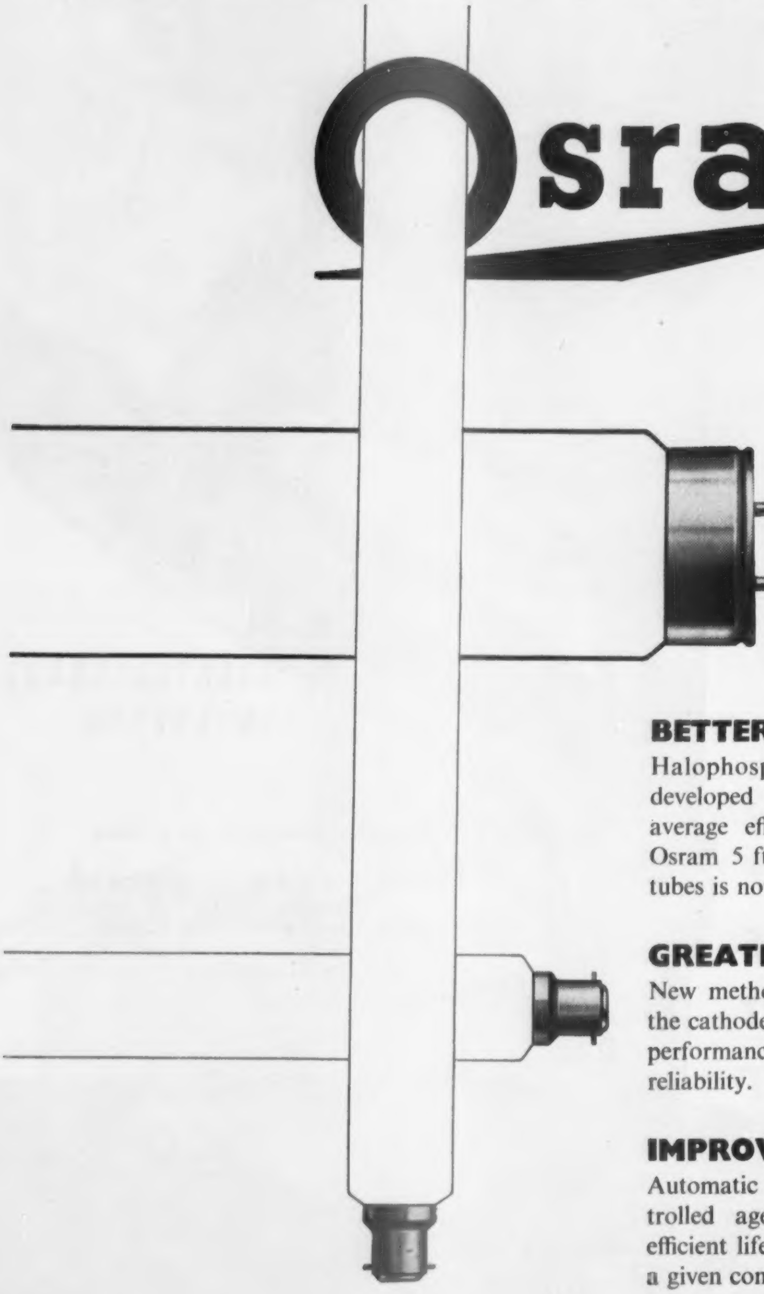
Keen interest in improved



Osram TUBES

BETTER EFFICIENCY

Halophosphate powders have been developed which give more light. The average efficiency through life of the Osram 5 ft. Daylight and Warm White tubes is now up by 12½%.

GREATER RELIABILITY

New methods of automatically coating the cathodes result in even more uniform performance which makes for greater reliability.

IMPROVED STAMINA

Automatic pumping and carefully controlled ageing help to ensure long, efficient life which means more light for a given consumption of electricity.

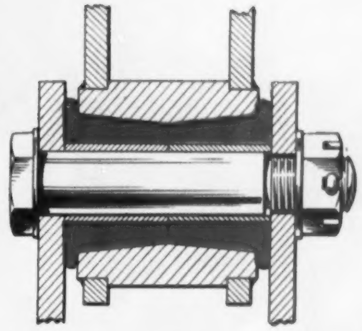
Osram tubes for STAMINA

A G.E.C. Product. The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

Silentbloc

FLANGELESS TAPER BUSHES

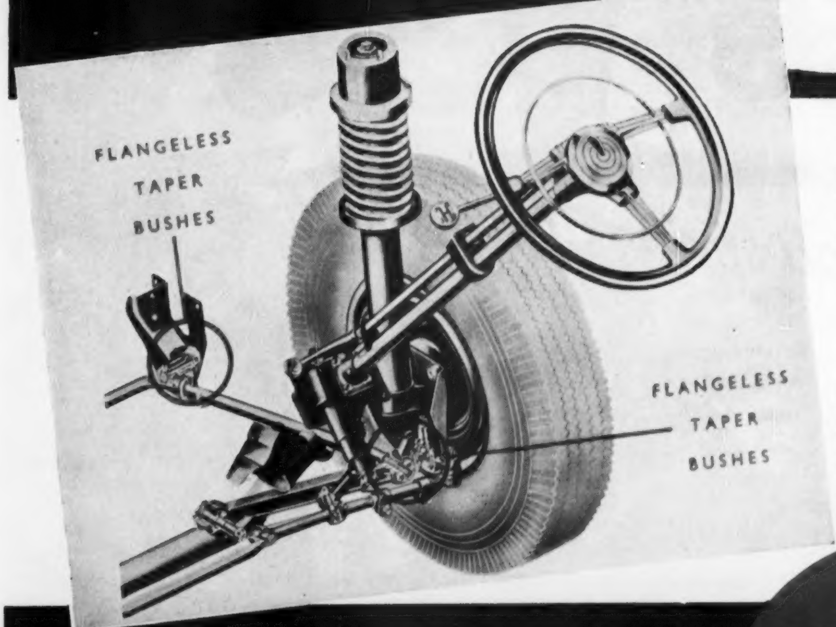
for I.F.S systems



Scientific Development Cuts Costs

Constructed on the Silentbloc principle with a self-forming flange for extra-snug fitting and less wear these bushes ensure maximum efficiency at lowest cost.

Right: Flangeless Taper Bush sectioned to show construction. In the housing flanges develop under compression.



★After exhaustive testing Ford Motor Company Ltd. now fit Silentbloc Flangeless Taper Bushes in the I.F.S. of the "Consul" and "Zephyr Six".

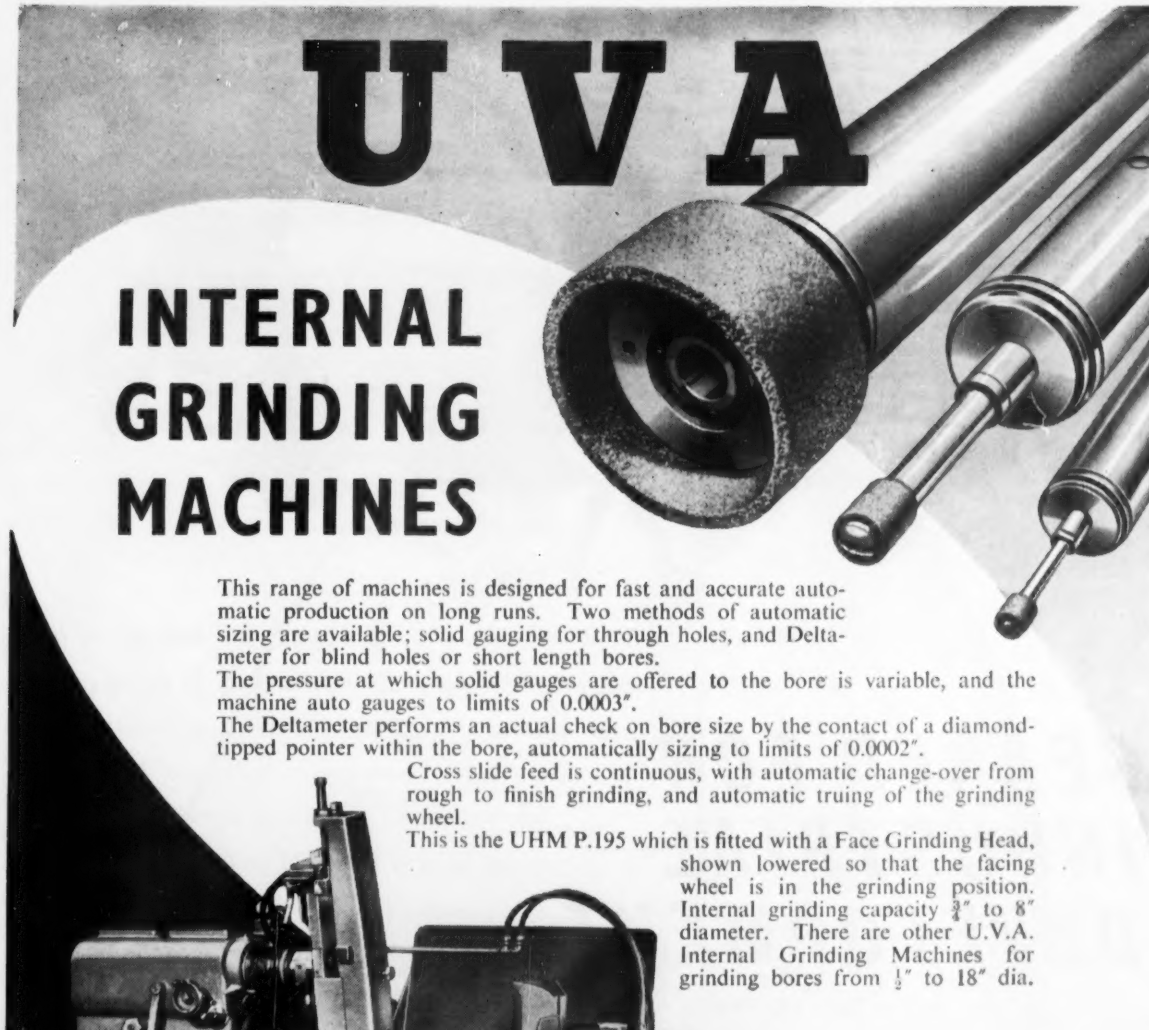
Left: Front Suspension of the "Consul" and "Zephyr Six".

Flangeless Taper Bushes and Frustacon mountings provide the first complete and scientifically designed rubber insulation between wheel and body.

SILENTBLOC LTD.
VICTORIA GARDENS
LONDON, W. II. TEL. PARK 9821

DESIGNERS AND MANUFACTURERS OF RESILIENT UNITS FOR MORE THAN 25 YEARS


Only good springs from sound advice
You can consult us about suspension spring design, or you can ask us to make springs to your specifications. In either case you get the springs you want, when you want them, and Toledo Woodhead Springs are good springs.
We are specialists in design and manufacture of Coil, Laminated or Torsion Bar Suspension Springs for every type of automotive vehicle—also Tine Springs for cultivators and agricultural implements if you are interested.
Not to mention "KANTLINK" Spring Washers—millions and millions of *them!*
TOLEDO WOODHEAD SPRINGS LIMITED·SHEFFIELD 3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INTERNAL GRINDING MACHINES
This range of machines is designed for fast and accurate automatic production on long runs. Two methods of automatic sizing are available; solid gauging for through holes, and Deltameter for blind holes or short length bores.
The pressure at which solid gauges are offered to the bore is variable, and the machine auto gauges to limits of 0.0003″.
The Deltameter performs an actual check on bore size by the contact of a diamond-tipped pointer within the bore, automatically sizing to limits of 0.0002″.
Cross slide feed is continuous, with automatic change-over from rough to finish grinding, and automatic truing of the grinding wheel.
This is the UHM P.195 which is fitted with a Face Grinding Head, shown lowered so that the facing wheel is in the grinding position. Internal grinding capacity ¾″ to 8″ diameter. There are other U.V.A. Internal Grinding Machines for grinding bores from ½″ to 18″ dia.
For close tolerance mass production
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LONDON · BRISTOL · BIRMINGHAM · MANCHESTER
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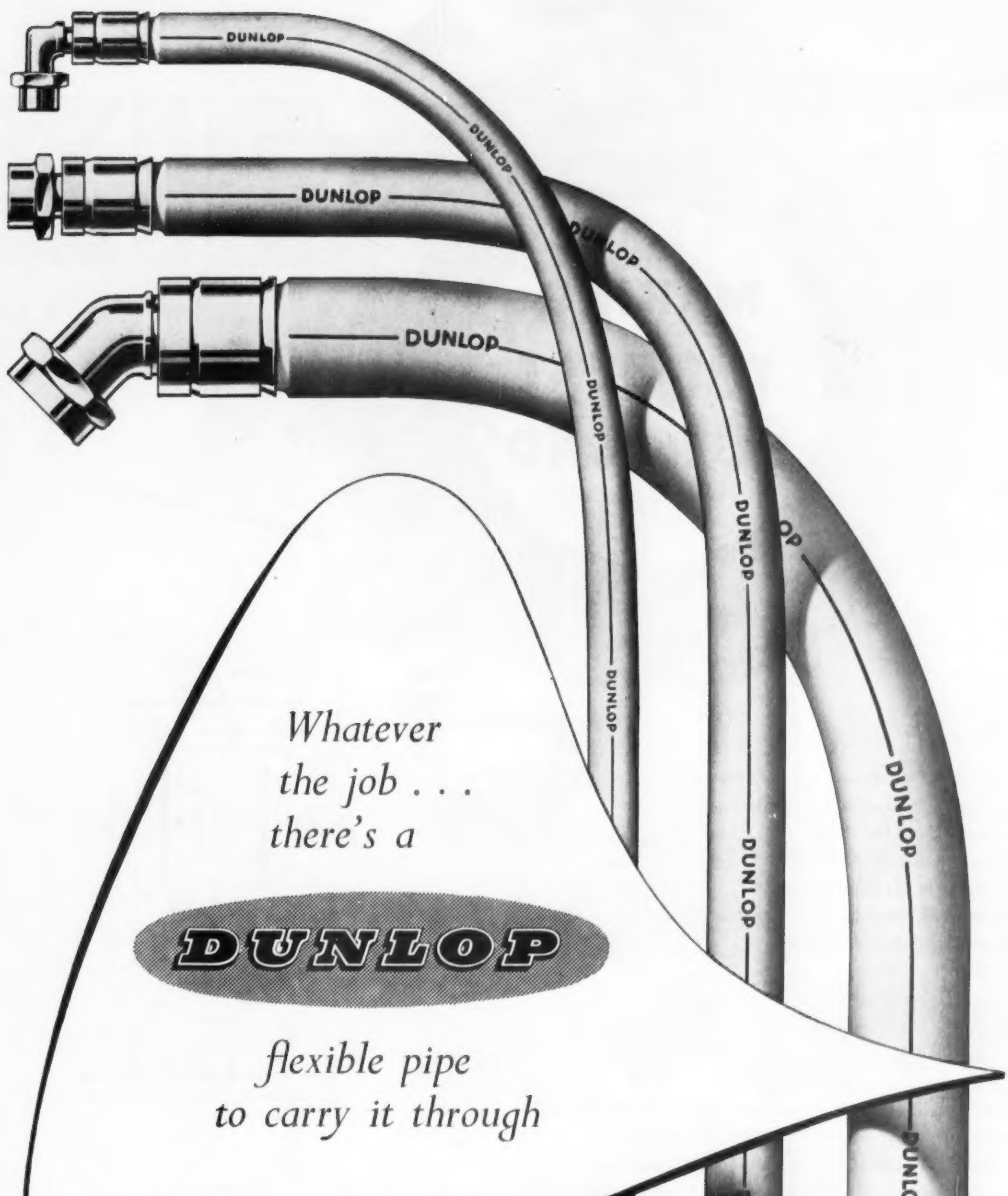
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Whatever the job . . . there's a
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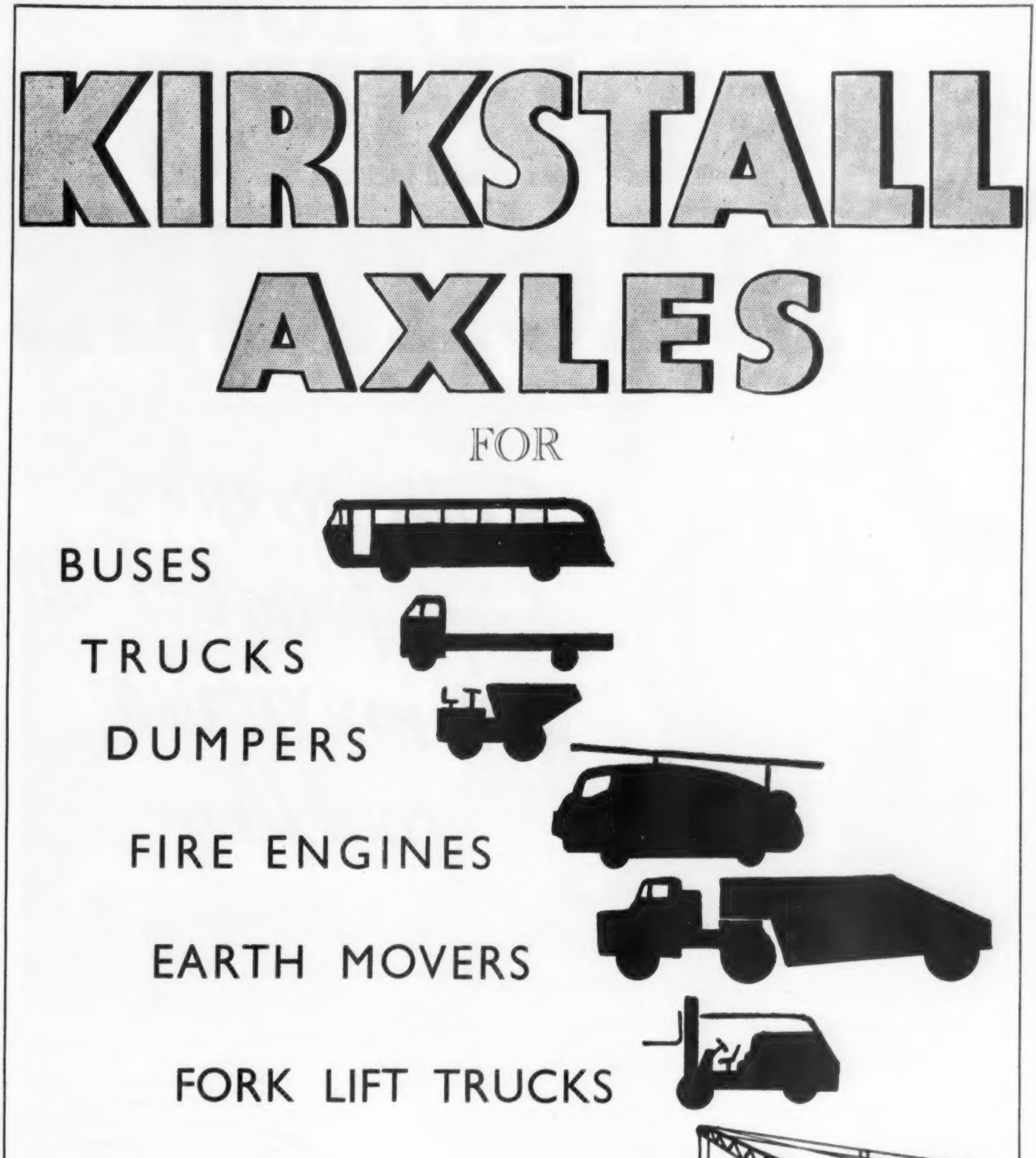
flexible pipe to carry it through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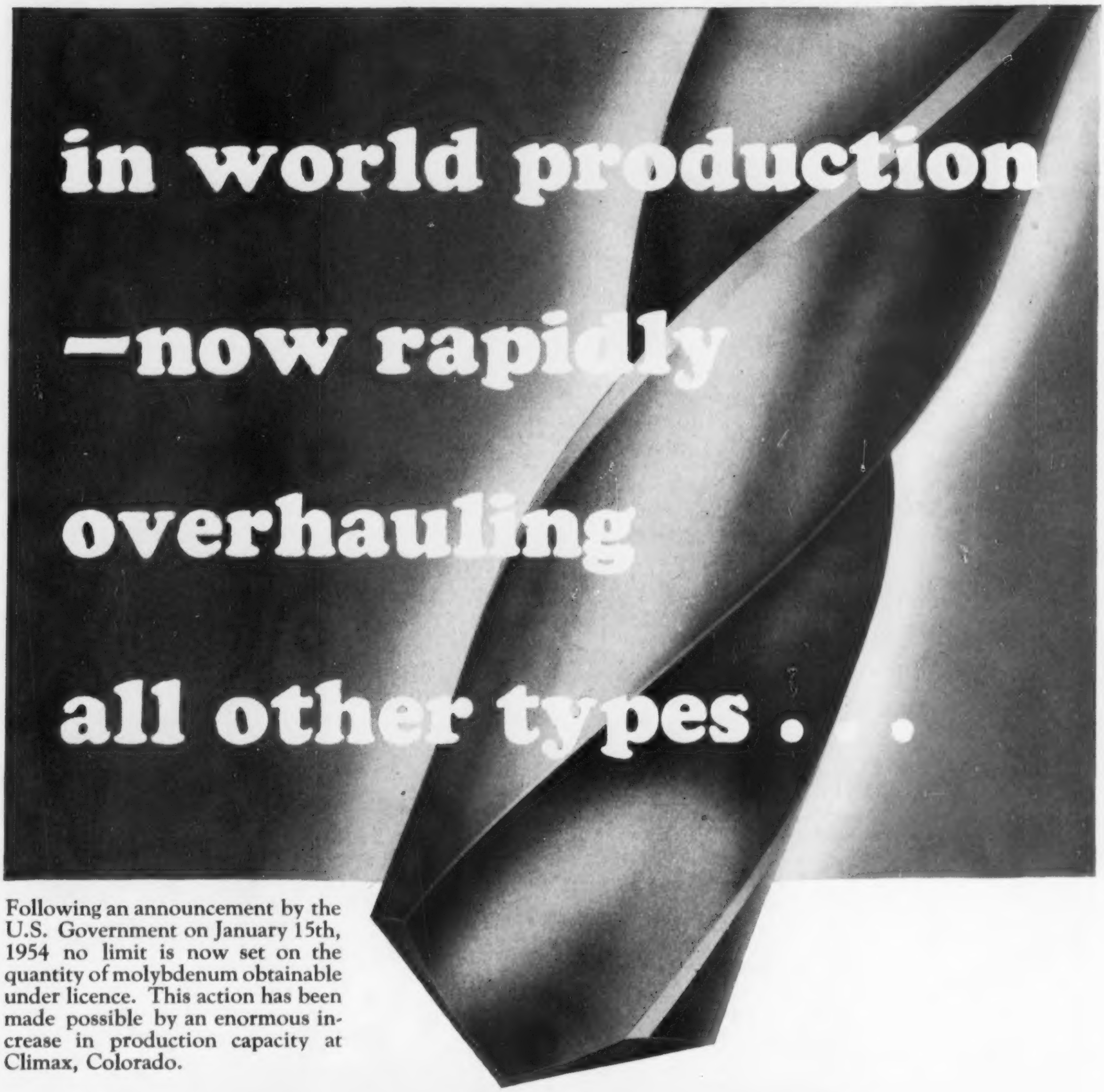
F.P.1

MOLYBDENUM HIGH SPEED STEELS



Following an announcement by the U.S. Government on January 15th, 1954 no limit is now set on the quantity of molybdenum obtainable under licence. This action has been made possible by an enormous increase in production capacity at Climax, Colorado.

MOLY

Climax Molybdenum Company of Europe Ltd.

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10% EXTRA OUT OF THE BLUE
"SPEEDICUT" DRILLS
FIRTH BROWN TOOLS LTD.
SPEEDICUT WORKS, CARLISLE STREET EAST,
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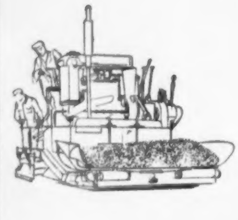

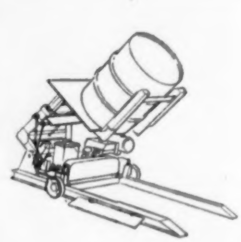

Whatever the shape . .

to be sure

you will use . . .

Smethwick Drop Forgings

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THE GACO M.I. OIL SEAL

The Scientifically Designed Oil Seal for Rotary Shafts. A Gaco Product.

1. Deep rim affords perfect Spring Retention.
2. Large Face Angle brings Sealing Edge well below spring.
3. Knife edge Contact at Sealing Point.
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5. This section stiffened to prevent deformation under load.
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7. Flexible Web.
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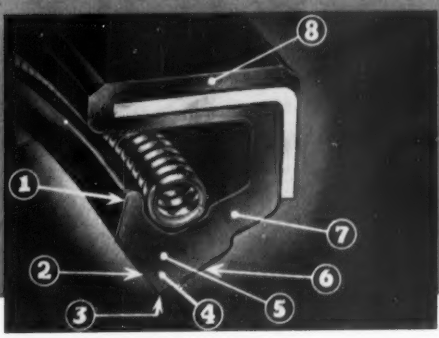

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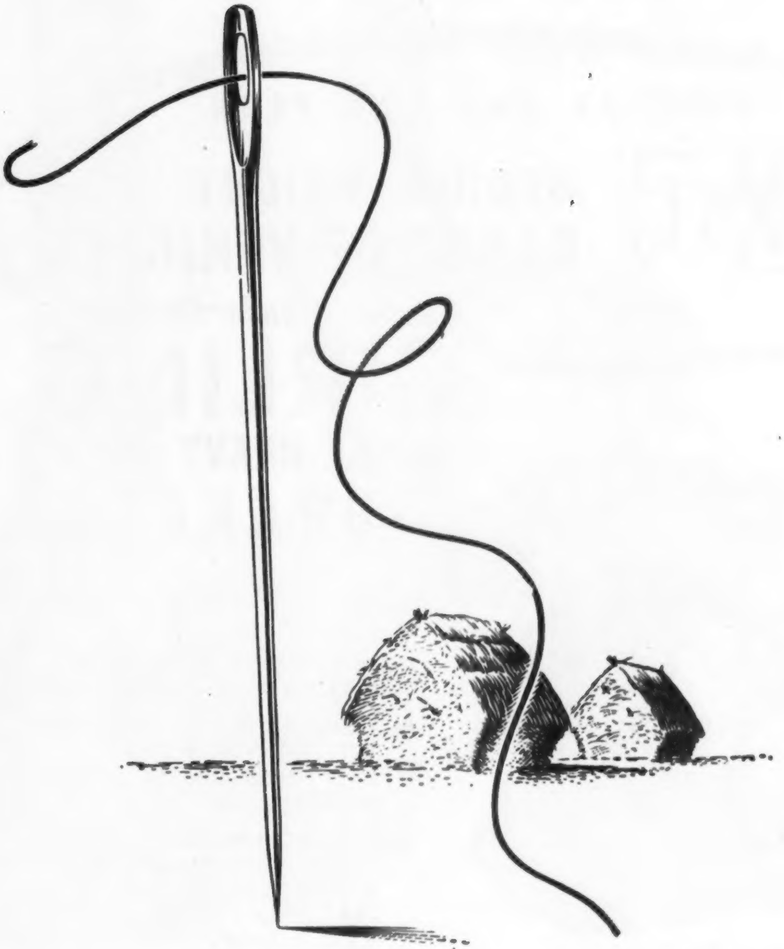
GEORGE ANGUS & Co LTD

FLUID SEALING ENGINEERS

NEWCASTLE UPON TYNE, 6



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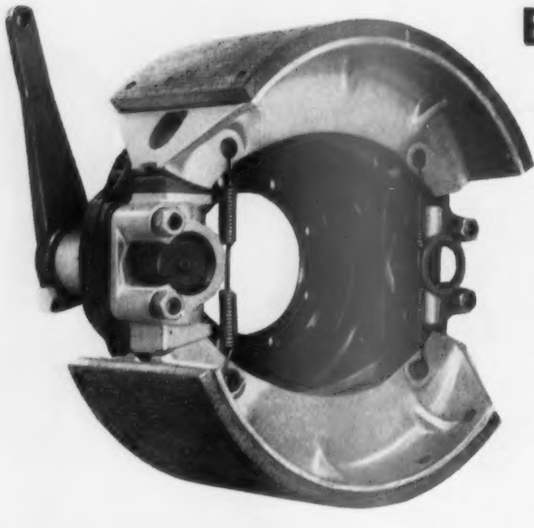
A·E·C MEDIUM WEIGHT RANGE OF VEHICLES

now standardise on

GIRLING EXTRA HEAVY DUTY BRAKES



- ★ MOUNTED ON HEAVY GAUGE TORQUE PLATES
- ★ MEEHANITE CAST SHOES WITH TWIN WEBS BUTTRESSED FOR EXTRA RIGIDITY
- ★ INTERCHANGEABLE CAM OPERATED 'FIXED CAM' ASSEMBLIES GIVING A MAXIMUM SHOE LIFT OF 0.170 INCHES
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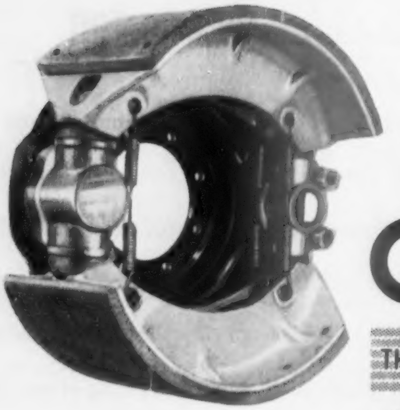

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Way Out Ahead

GIRLING LTD. KINGS ROAD
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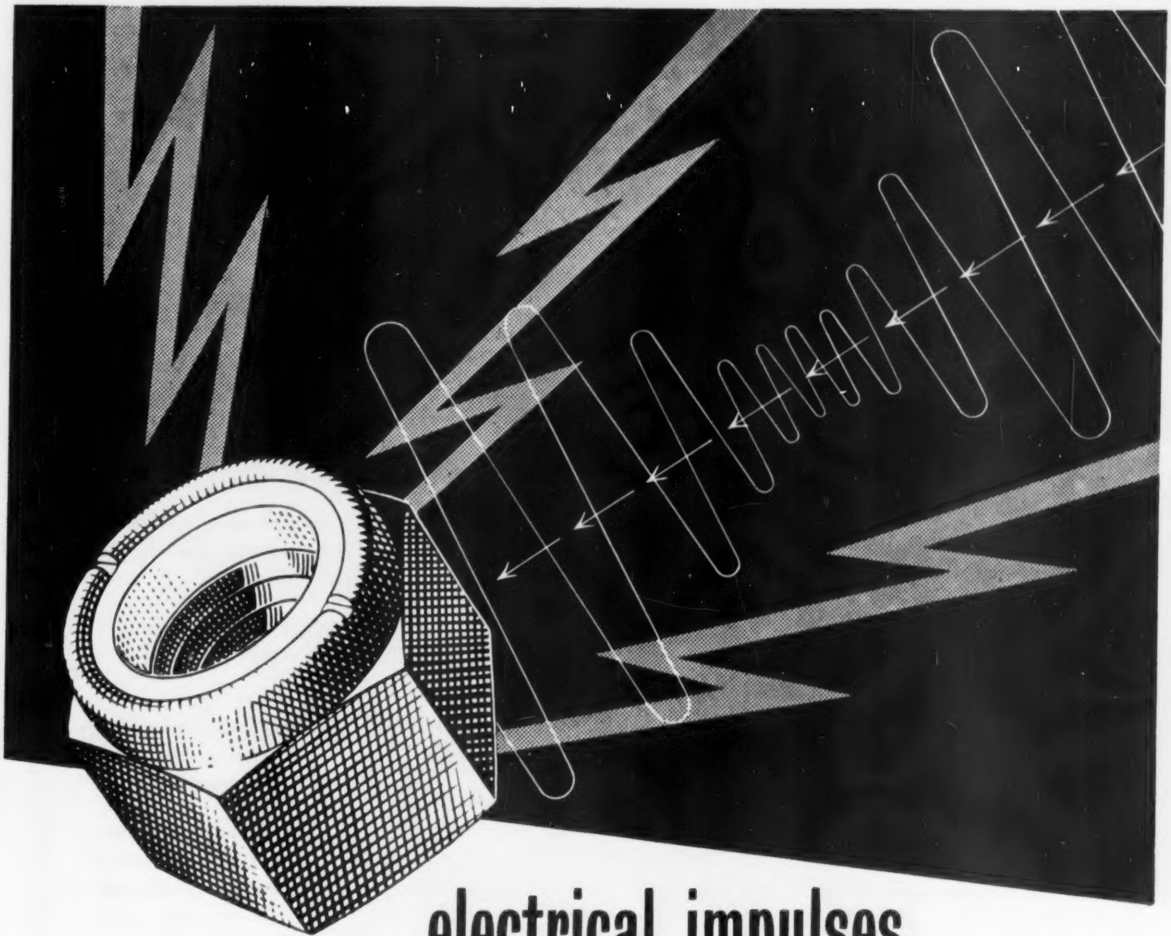


electrical impulses give any ordinary nut quite a turn . . .

But not the Nyloc. Fix it on any piece of electrical equipment and it stays fixed. It can be used over and over again, no matter how many times the equipment is dismantled and reassembled. The Nyloc behaves in the same tenacious way when subjected to mechanical vibration, sudden temperature changes, tensioning or immersion in oily liquids. Thread irregularities don't affect it in the least. The secret's in the nylon insert which moulds itself round the bolt thread and keeps the nut locked tight until *you* decide to remove it.

Anywhere a nut works loose you need a Simmonds self-locking nut. It may be a Nyloc, or a Fibre Nut  with fibre insert, or a Pinnacle Nut  with metal diaphragm. We'll be glad to tell you which is best for your particular job.

. . . but nothing rattles the NYLOC

SIMMONDS AEROCESSORIES LIMITED, TREFOREST, PONTYPRIDD, GLAMORGAN.

Branches: London, Birmingham, Stockholm, Copenhagen, Melbourne, Sydney, Amsterdam and Milan

A MEMBER OF THE FIRTH CLEVELAND GROUP

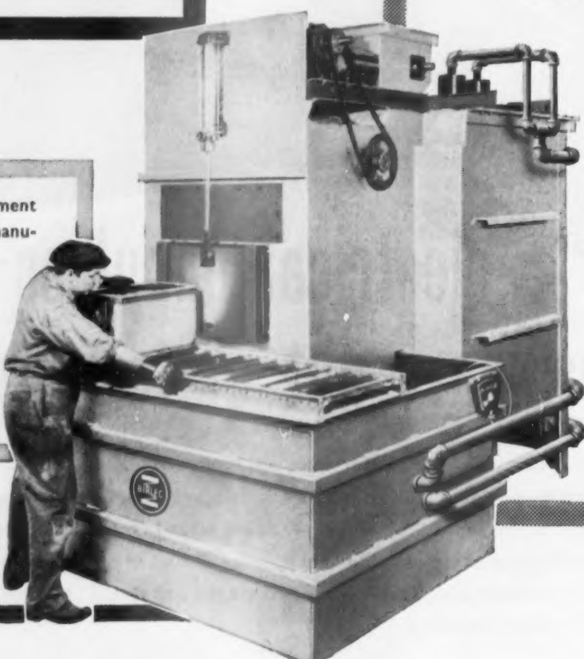
CBC 10M

CARBO-NITRIDING IN BIRLEC-DOW FURNACES

Carbo - nitriding replaces liquid cyaniding by a gaseous process, giving equivalent cases at much lower operating costs. With a greater penetration rate, lower temperatures can be used, thus reducing distortion.

The BIRLEC-DOW furnace

- ★ A gas-fired batch unit, enabling a wide range of components to be heat-treated.
- ★ Totally enclosed, heating and quenching being carried out without exposure to the air.
- ★ Built-in atmosphere generator, cutting down floor space requirements.
- ★ High heat storage efficiency, giving rapid temperature recovery with fresh charges.
- ★ Efficient atmosphere circulation, permitting dense loads of closely packed articles to be handled.
- ★ Semi-mechanised, reducing labour requirements and providing good working conditions.



By exclusive arrangement with the American manufacturing patentees, BIRLEC LIMITED have now added the DOW carbo-nitriding furnace to their wide range of heat-treatment equipment.

Standard designs are available from 250 lb. per hour (carbo-nitriding with .003" case) upwards. Full design and operating data are available; **may we send further details?**

BIRLEC

BIRLEC LIMITED

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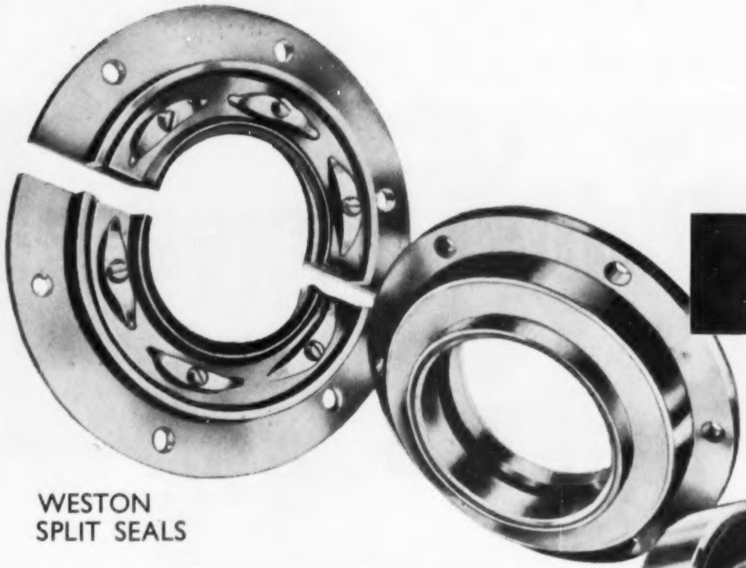
Sales and service offices in LONDON, SHEFFIELD *and* GLASGOW



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OIL SEALS

WESTON
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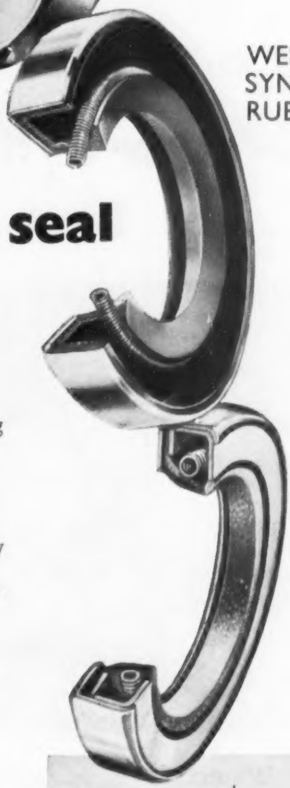
WESTON
'IMPAX'
FACE-TYPE SEALS



WESTON
SYNTHETIC
RUBBER SEALS

It all depends on the seal

The operational efficiency of any type of mechanical equipment depends on the reliability and successful functioning of the oil seals. With this in mind, Charles Weston and Co. Ltd. have produced during the last 21 years a range of oil seals second to none for efficiency, ease of installation, quality and precision. There is a Weston Seal to suit most mechanisms but we do invite users to let us solve any particular sealing problem arising from speed, temperature, pressure or fluids.

WESTON
LEATHER
SEALS

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THE SYMBOL OF CONFIDENCE IN WORKMANSHIP FOR 21 YEARS.

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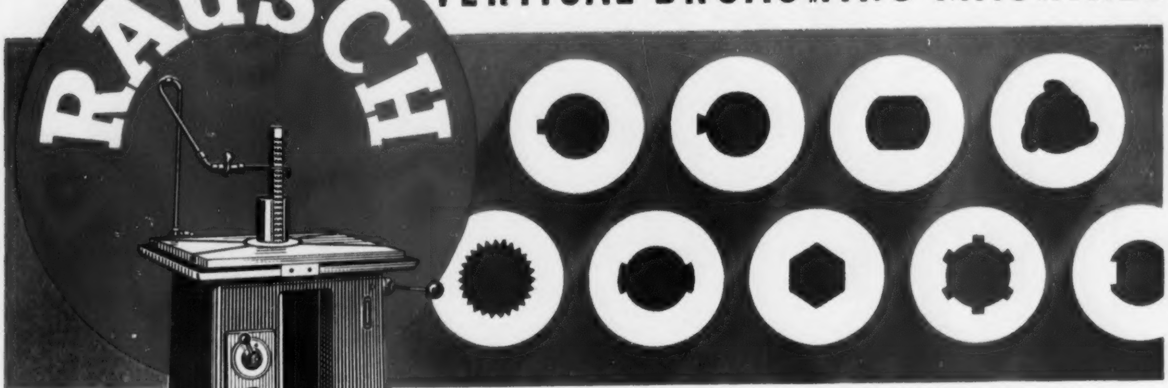
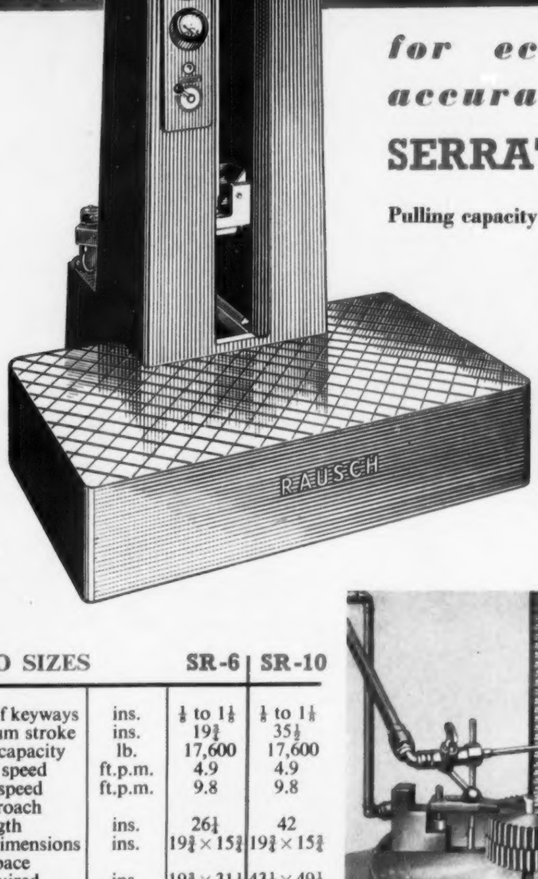
VERTICAL BROACHING MACHINES





for economical production of accurate **KEYWAYS SPLINES SERRATIONS SLOTS PROFILES**

Pulling capacity 17,600 lb.

RAUSCH, Types SR-6 and SR-10, are multi-purpose machines. While they are ideal for the fast and accurate broaching of common or staggered keyways and dovetail or half-round slots, they are equally efficient when producing serrations or splines and square or hexagon and similar internal profiles. They will broach to required limits rough bored work or rough bores in castings with considerable savings over other methods.

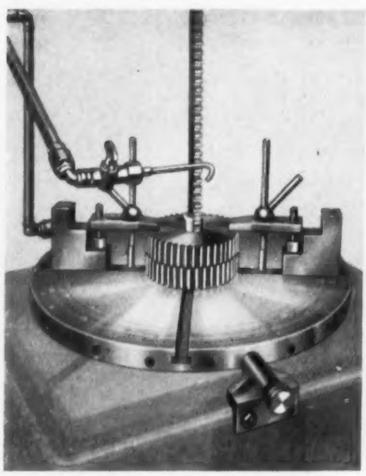
LOW COST—SIMPLE TO OPERATE

Simplicity in operation has been achieved by simplicity in design which in turn permits them to be marketed at remarkably low cost. They employ comparatively inexpensive short broaches yet they compare favourably with big machines in speed and accuracy and occupy little floor space.

Type SR10

KEYWAY ACCURACY

Unlike the one-purpose keyway cutter or key-seating machine the RAUSCH can be employed for a variety of broaching requirements, but will produce work of higher accuracy than is possible by the single cutting tool system of the shaping machine or draw-cut keyseater. In most instances there is no need to clamp the work on the RAUSCH which handles work of unlimited diameter and can broach several components simultaneously.



INDEXING ATTACHMENT

For work where a certain spacing is required, e.g., for cutting two keyways 90, 120 *or* 180 *degrees apart, or in instances where certain profiles do not warrant a complete-form broach, a simple but highly accurate indexing attachment can be supplied as illustrated. The standard index plate is arranged for* 2, 3, 4, 5, 6, 8, 10 *and* 12 *divisions.*

TWO SIZES		SR-6	SR-10
Width of keyways	ins.	$\frac{1}{8}$ to $1\frac{1}{8}$	$\frac{1}{8}$ to $1\frac{1}{8}$
Maximum stroke	ins.	$19\frac{3}{4}$	$35\frac{1}{2}$
Pulling capacity	lb.	17,600	17,600
Cutting speed	ft.p.m.	4.9	4.9
Return speed	ft.p.m.	9.8	9.8
Max. Broach length	ins.	$26\frac{1}{4}$	42
Table Dimensions	ins.	$19\frac{3}{4} \times 15\frac{3}{4}$	$19\frac{3}{4} \times 15\frac{3}{4}$
Floor space required	ins.	$19\frac{3}{4} \times 31\frac{1}{2}$	$43\frac{1}{4} \times 49\frac{1}{4}$
Height of Machine	ins.	$39\frac{3}{8}$	$55\frac{1}{8}$
Drive (self-contained) Motor	h.p.	5.5	5.5
Speed	r.p.m.	1450	1450

Sole Agents: LEO C. STEINLE LTD. BIRMINGHAM

Please send for further particulars of these versatile and economical machines.

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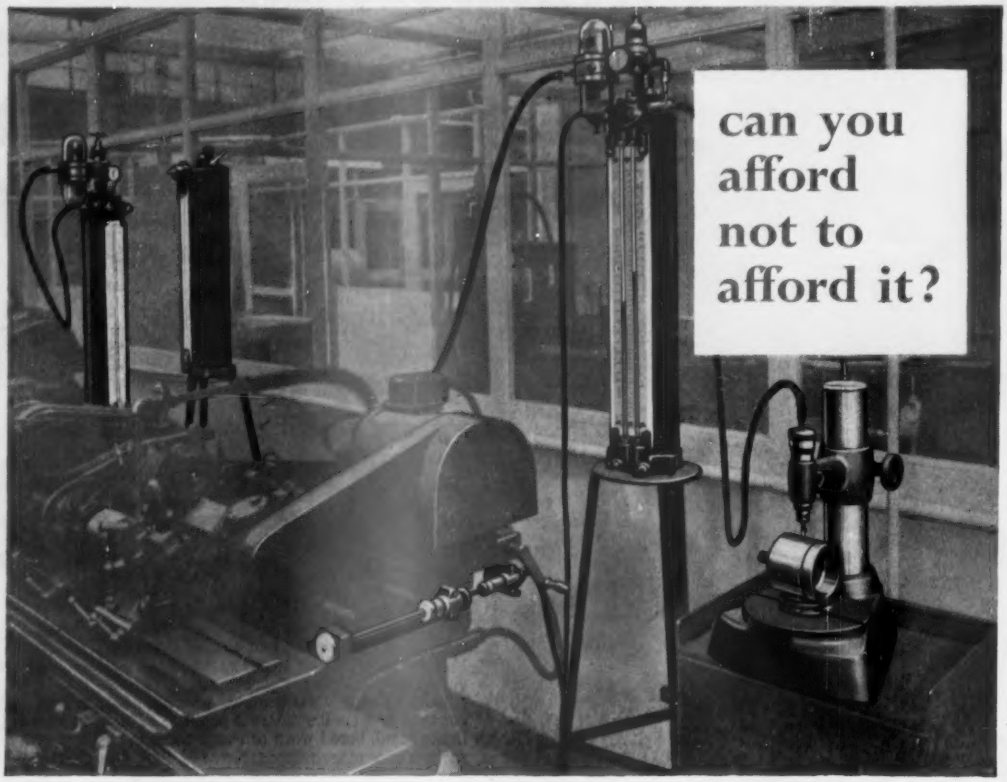
can you afford not to afford it?

FENNER TAPER-LOCK BUSHES—do they grip?

BRITISH PATENT NO. 592912

You bet they do!

Slip the pulley and bush over the shaft, tighten the flush-fitting screws and you have the grip of a shrunk-on job—yet off in a minute when a change is required.

Taper-Lock bushes and pulleys, in 306 basic sizes for A, B and C Section V-Belts, provide thousands of drive combinations, with delivery from stock. Mark your next pulley enquiry for "Taper-Lock" and send it to your nearest Fenner Branch or Distributor.

- ***BEAUTIFULLY SIMPLE—STREAMLINED FOR EFFICIENCY AND SAFETY***
- ***FIT FENNER TAPER-LOCK BUSHES—SAVE MAN HOURS AND RAISE YOUR PRODUCTIVE CAPACITY***

J. H. FENNER & CO. LTD., HULL, YORKSHIRE

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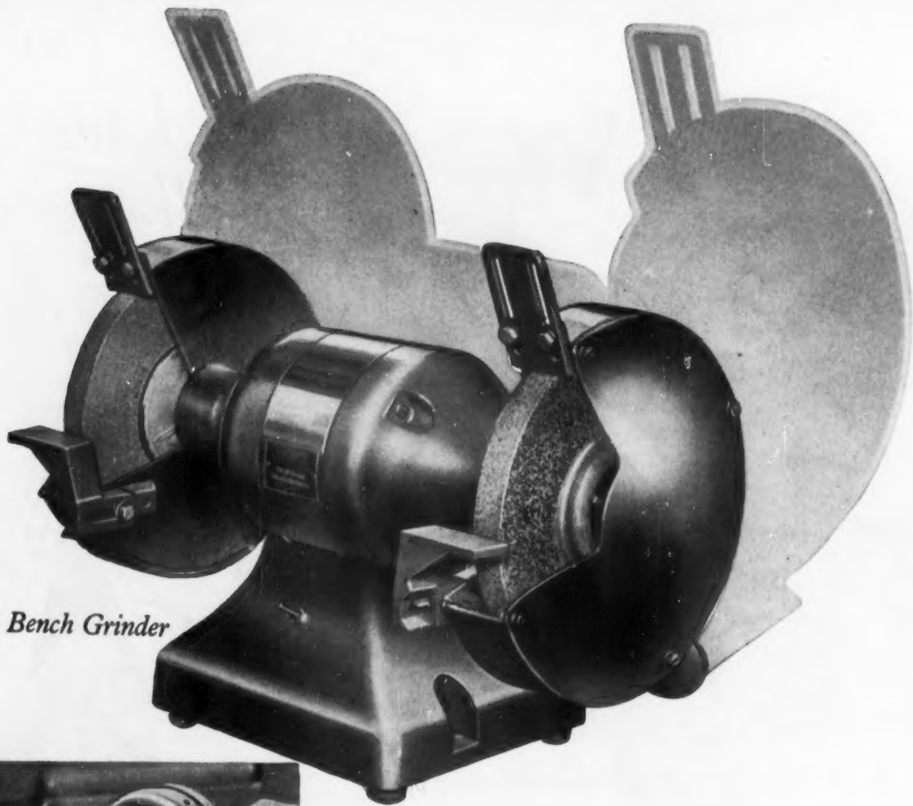
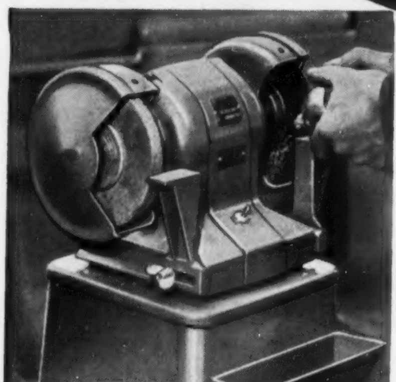


The 10" Bench Grinder



The 6" Standard Bench Grinder *a neat, compact powerful tool.*

***All models** in the range can be fitted with extension spindle & rag buff and all can be pedestal mounted.*

POWER AT YOUR FINGERTIPS . . .

To step up output *without increasing your production costs* . Black & Decker offer you the choice of four dependable Bench Grinders . . . sturdy adaptable tools that give you better buffing . . . more efficient wire wheel brushing . . . faster 'run-of-shop' grinding and tool sharpening. Productivity demands B&D grinders, they are designed for constant use on a variety of jobs, they are part of the world famous B&D range which includes Drills, Sanders, Saws, Vitrifiers, etc.

Quicker and Better with

Black & Decker

PORTABLE ELECTRIC TOOLS

Write for catalogue   Demonstration of any tool on request.

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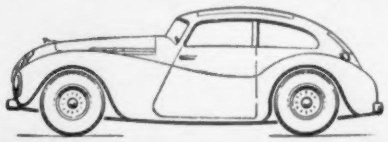

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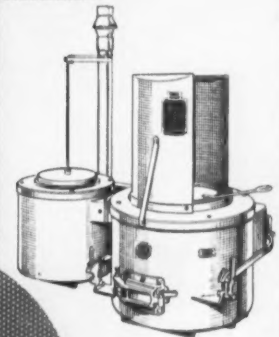

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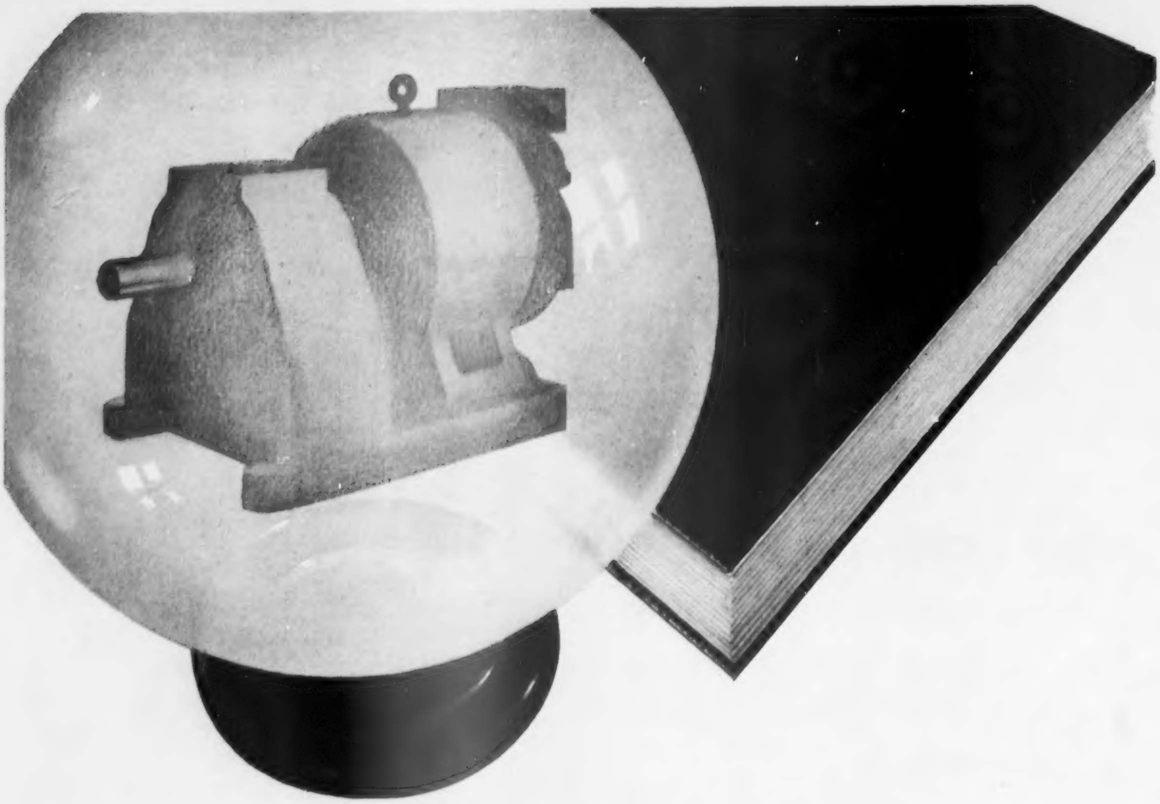

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AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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Brussels

CONTINENTAL motor shows are always of considerable interest to engineers, because of the wide range of technical features on view that are unconventional by British standards. This is no less true of the commercial vehicles than of the private cars, as may be gathered from the review of the commercial vehicle section of the Brussels Show, which appears in this issue.

So far as engines are concerned, there is a tendency towards the adoption of power units of larger output. One of the latest developments is the Magirus Deutz, V-twelve, air-cooled engine, which is normally governed to develop 230 b.h.p. Most of the problems that are associated with air cooling of large power units of this type seem to have been overcome by these manufacturers, and it would appear that relatively uniform cooling of the cylinders has been obtained. Although these engines are noisy by comparison with water-cooled units, the baffles used to distribute the air round the cylinders enclose them to such an extent that they are appreciably quieter than might be expected.

Engine installation

Engine mounting arrangements currently being adopted are generally much more flexible than hitherto; in fact, the systems used in many medium and heavy commercial vehicles are similar in principle to those commonly employed in private cars. There are, however, two aspects of the mounting problem that require more attention in commercial vehicles. One is the provision of bump and rebound stops, which have no effect on the isolation of normal engine vibrations, but which prevent undue amplitudes of motion of the power unit relative to the chassis when traversing exceptionally rough terrain. The other is the provision of torque reaction stops.

Opinions differ widely as to the best position for engines in both passenger transport and goods chassis. Some favour the underfloor, horizontal engine layout, but this tends to raise floor level, and the frame side members generally have to be cranked to accommodate the power unit. The Brossel arrangement, in which the engine is installed longitudinally, at the rear, with the plane of the cylinder axes at about 45 deg from the horizontal, is a good compromise. With this layout, the floor level is kept down, the frame is straight throughout its length and little body space is lost behind the rear seats.

The Henschel installation, in which the power unit is positioned vertically in a transverse plane at the front, is good both so far as accessibility is concerned and because of the elimination of the long run of controls that is necessary with any but forward engined layouts. Even in smaller vehicles, such as pick-ups and vans, a transverse engine arrangement can be used to advantage particularly if it occupies the space under the driver's seat, as in the Goliath chassis. However, it is probable that this is only economically practicable when a similar arrangement is used for a private car, so that the engine and transmission components can be made common to both ranges of vehicles.

There were few new features in transmission systems. However, there are signs of increasing interest in automatic and semi-automatic types, and these are likely to be well received among operators of urban bus services. An example of this trend is the adoption of the Leyland pneumatically controlled Wilson-type box and control system for the Brossel chassis. Forward control has gained in popularity, and this year there were fewer examples of forward engined buses and coaches.

Suspension systems

A wide range of different suspension systems was on view at the exhibition, and it was evident that considerable attention is being devoted to this aspect of the design of all classes of commercial vehicle. Some features, such as anti-roll bars, hardly appear to be essential at present on coach chassis, but they may become more popular if softer suspension rates are adopted.

Two-rate suspension systems, in which helper springs are employed, have been in general use for very many years, but they still leave much to be desired so far as ride in the lightly-laden condition is concerned. A three-rate system can, of course, be obtained by elevating one end of the helper spring relative to the other, or by making a similar adjustment to the relative heights of the support brackets. Nevertheless, these arrangements still are not entirely satisfactory. In light commercial vehicles, because of their soft suspension systems, a helper spring at the rear would appear to be a useful feature, and the additional coil spring, as installed in the Fiat vehicles, has much to commend it.

Rubber sprung suspension systems are not yet widely accepted, but the use of large rubber units instead of slider brackets or shackles to carry the ends of semi-elliptic springs, as in the Miesse chassis, would appear

to be attractive for passenger transport chassis. Possibly more attention will have to be devoted to the fore and aft location of the axle if such systems are used.

Diesel or Petrol

ONCE again there is a possibility that fiscal policy rather than purely technical considerations may affect the trend of engine development. Fortunately, the effect will not be so stultifying as was the unlamented arbitrary horse-power formula, since the policy affects all types of engine equally and does not place a premium on the development of long stroke/small bore, high speed engines.

Owing to the inordinately high rate of taxation on motor fuels, the actual fuel costs now represent a very high proportion of total running costs. This has been fully recognised by designers and there is no doubt that present-day vehicles are more economical in fuel consumption than their pre-war counterparts, in part due to intrinsically more efficient engines and in part to reductions in vehicle weights. The search for even greater economy is causing a trend towards using diesel engines in applications which have hitherto been considered as peculiarly the province of the conventional petrol engine.

As yet, the trend is more marked on the Continent than in this country. Here, certain taxi-cabs are now diesel powered, one of the Big Six is introducing an estate car with a diesel engine and one popular light van is more often than not diesel powered. On the Continent three makers, Fiat, Mercedes-Benz and Borgward are offering production passenger cars with diesel engines.

In comparison with an equivalent petrol engine, a diesel engine will, of course, be much more economical in fuel consumption, but whether this considerable advantage will offset other factors is open to doubt. In the first place, the change-over will considerably increase the initial cost of a vehicle. Generally, a diesel costs about twice as much as a petrol engine. The effect on the vehicle price is in the order of 12-15 per cent for models now produced on the Continent; for example, a Mercedes 180 with a diesel engine costs £1,220 against £1,100 for the car with a petrol engine; comparative figures for the Fiat 1400 are £909 and £795.

Apart from fuel consumption, so far as performance is concerned for normal passenger car work, the advantage undoubtedly lies with the normal petrol power unit. This is particularly true of acceleration through the gears and general flexibility. Maximum speeds are reduced by more than 10 per cent and the performance is generally more sluggish. All that can be set against this is the economy in fuel consumption. For normal running conditions the saving will probably be in the order of 25 to 30 per cent; in City traffic and similar conditions, the saving would be even greater.

Many, probably most, motorists would be prepared to accept the reduced performance to obtain such savings in fuel costs, but whether there are many who will be prepared to meet the higher first cost is open to considerable doubt. Only those who do much more than normal mileages will find the saving in running costs sufficient to warrant the extra initial outlay.

Therefore, a fundamental question is whether there is any prospect of a substantial reduction in the production costs for diesel engines. The engine itself, merely because of its greater weight in comparison with an equivalent petrol engine, must remain more expensive, although the price difference need not be great. If any saving is to be made it must be in the pump and injection equipment. This equipment is much more expensive than a carburetter, and there is no reason for expecting any appreciable reduction in price in the near future. In some quarters there is a belief that increased quantities would lead to substantial production economies, but it does not seem to be well founded. The pump and nozzles must be made to instrument standards of accuracy and finish, and there is no reason for thinking that even a great increase in output would lead to a marked reduction in costs.

CONTENTS

BRUSSELS SHOW

Outstanding Features of the Continental Chassis Exhibited in the Commercial Vehicle Section

THE commercial vehicle section of the 37th Salon d'Automobile et de Cycle included a wider range of new and modified chassis than was shown in 1953. This, of course, was partly due to the fact that last year a number of well-known manufacturers abstained from taking part in the Exhibition. In the recent Show, 70 manufacturers of commercial vehicles and 17 coachbuilders making bodies for these types of vehicle displayed their products. It is of interest to note that among the commercial vehicle manufacturers, the German exhibitors were the most numerous, as can be seen from the following list:

Germany	19
Great Britain	15
United States	13
France	13
Belgium	4
Holland	2
Sweden	2
Italy	1
Austria	1

The Brossel A 95 DAR

A number of the Continental manufacturers were showing chassis in which British engines and gearboxes are fitted. Among these exhibits was the Brossel A 95 DAR, rear-engined coach chassis, with forward control. In this, the power unit employed is the 9·8 litre Leyland engine; and it is used in conjunction with the fluid flywheel and pneumatically controlled, four-speed, Wilson-type gearbox of the well-known Leyland two-pedal control system. Whereas in the Leyland chassis this engine is mounted horizontally, the Belgian manufacturers have modified the installation and set it at an angle of approximately 45 deg. By so doing, they have avoided the necessity of having to crank the frame in order to make room for the engine.

The engine has six cylinders and the bore and stroke are 121·9 mm and 139·7 mm respectively. Its compression ratio is 15·75 : 1. The maximum power developed in the Brossel installation is said to be 130 b.h.p. at 1,800 r.p.m., and the maximum torque of 404 lb-ft is obtained at 1,000 r.p.m. In this chassis, the fuel capacity is 33 gallons, and the sump holds 5 gallons. The capacity of the water system is 8¾ gallons.

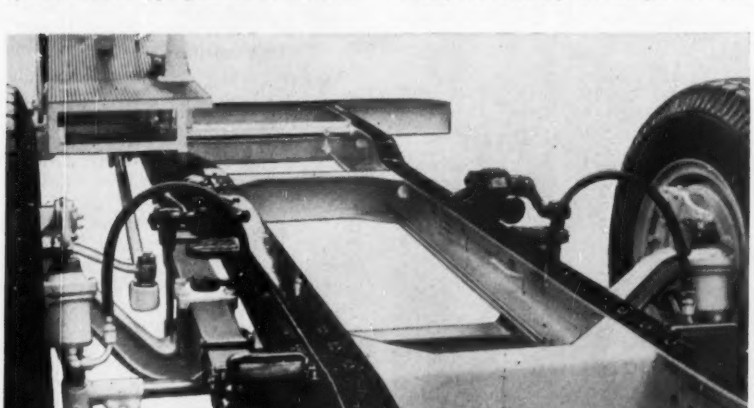
Semi-elliptic springs are employed at both the front and the rear. At the front, lever-type shock absorbers are bolted on the frame and the springs are mounted on top of the axle, whereas at the rear there are no shock absorbers and the springs are underslung. Twin wheel equipment is used at the rear and single at the front. The tyres are Englebert D20 or 10.00 GR.

The weight of the bare chassis is 5·4 tons and it is designed for an all-up vehicle weight of 15·2 tons. On the front axle, the load is 6 tons and on the rear it is 9·2 tons. The wheelbase is 16 ft 5 in, and the overall width of the chassis is 8 ft 1 in. By British standards, the rear overhang, which is about 9 ft 9 in, is exceptionally large and it would, of course, be illegal in this country. The height of the top of the frame above the ground is 23½ in.

The outstanding feature of this vehicle is its low floor, particularly at the front entrance. It is claimed that by installing the engine at an angle at the rear instead of horizontally in the centre, a reduction of 2½ in in frame height has been obtained. The height of the floor above the ground is about 26 in. To clear the gearbox, the rear seat is higher than the remainder, and the top of its 5 in thick cushion is 21 in above a 5 in step on the floor. From the rear of the squab to the back of the vehicle the distance is 28 in.

A Neate multi-pull hand brake is fitted on the Brossel A 95 DAR

From the technical point of view, there are a number of interesting features on this chassis. The engine and gearbox are mounted on six rubber units. At the front, two large horn-shaped supports are bolted one to each side of the crankcase to carry the lower eyes of a pair of rubber bushed pendant links. The upper eyes of these links are bolted to a forged cross member which is secured inside the channel section frame side members. The centre pair of mountings are of the rubber cone type. They are carried by brackets attached to the frame side members. These brackets are of rather complex form and have upward extensions welded to their front faces. An



The frame of the Brossel coach chassis is cranked inwards to provide clearance for the wheels on full lock

angle section cross member is bolted to the top of these two extensions and passes over the top of the flywheel casing. The mounting bracket attached to the engine is in the form of a plate clamped between the bellhousing and flywheel casing, and on each side of it are welded-on extensions which seat on top of the cone mountings. The rear pair of mountings are positioned one each side of the rear end of the gearbox. They furnish additional support for the gearbox, and are in the form of pendant rods, the upper ends of which are suspended from two brackets bolted to the frame. Their lower ends carry two more brackets bolted to the rear face of the gearbox casing. A thick rubber washer above and below each of the four brackets provides the flexibility necessary to afford a measure of vibration isolation.

In order to support the engine on such a long overhang, it has been necessary to reinforce the rear end of the frame which is of channel section and which, like the front end, is $3\frac{1}{2}$ in over the flanges by 7 in deep by 8 mm thick. The reinforcement has been effected by bolting a 3 in by 3 in by 8 mm angle section inside the side member. This angle section seats on the lower flange of the side member and its back is against the vertical wall. The cross member supporting the rear pair of engine mountings is bolted to this reinforcing angle, while the brackets carrying the intermediate pair of mountings are also secured to it. At the centre of the chassis, the depth of the side members is increased to 9 in.

The front end of the reinforcing angle for the engine butts against the lower flange of a channel-section cross member carrying the rear pair of mountings. A gusset joins the upper flange of the cross member to the top flange of the side member on each side. In front of this cross member, where the frame is cranked to clear the axle, the side member is closed by a plate welded to the inner edges of its flanges. This plate terminates at another channel-section cross member in front of the axle. This closing plate is a good feature, in that it supports the flanges which under load would otherwise tend to deform where they are cranked.

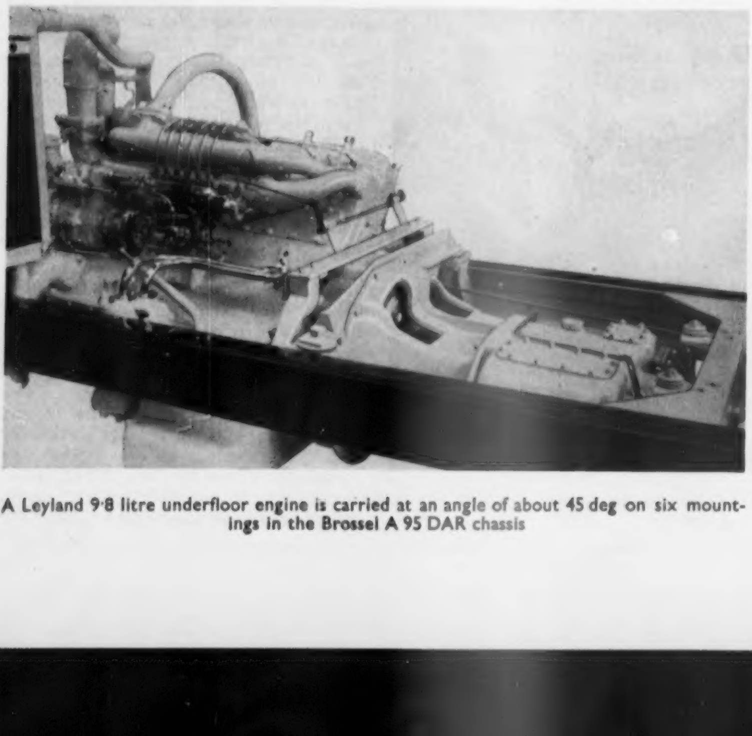
It is surprising that a discontinuity should be allowed to exist between the reinforcing angle supporting the engine at the rear and the flange of the cross member where it is riveted to the inner face of the lower flange of the side member. However, this arrangement is probably satisfactory because the lower flange is normally under compression, so the end loads in it are transferred across the butt joint and diffused through the end of the cross member into the closing plate. The gussets at the ends of the top flange of the cross member doubtless are adequate to redistribute the loads from the tension flanges of the side members.

Among the other features of interest is the radiator and fan installation. The radiator is mounted to one side of the engine and the fan is fully shrouded. Although the fully shrouded arrangement is widely employed on commercial vehicles and sometimes on private cars, it is not so efficient as at first sight would appear. The tendency is for the air to pass only through the area of the radiator block immediately in front of the fan disc.

The fan is unusual in that it has six blades, three of which are long and three short. This arrangement has probably been adopted to overcome a defect that is characteristic of almost all fans in motor vehicles. The defect referred to is the tendency for air to recirculate through the fan disc, and it arises because at the outer periphery of the disc the blades have a relatively high linear velocity and are working efficiently, whereas at the centre they have a low linear velocity and therefore are often ineffective. As a result, air flows in the normal direction from the periphery of the fan disc, but returns

The installation of the pneumatic controls of the Leyland two-pedal system in the Brossel A 95 DAR coach chassis

in the opposite direction near the hub to help to balance the low pressure between the fan and the radiator block. In this vehicle, because there is a larger effective blade area at the centre than at the periphery, this defect may well have been overcome. From the illustration, it can be seen that in addition to the V-belt drive between the front of the crankshaft and the fan, there is a triangulated V-belt arrangement to transmit the drive from the crankshaft to the water pump and generator. A screw-type adjuster, which is clearly visible in the illustration, can be used to move the pivot mounted generator to adjust the belt tension. Single belting is used throughout.

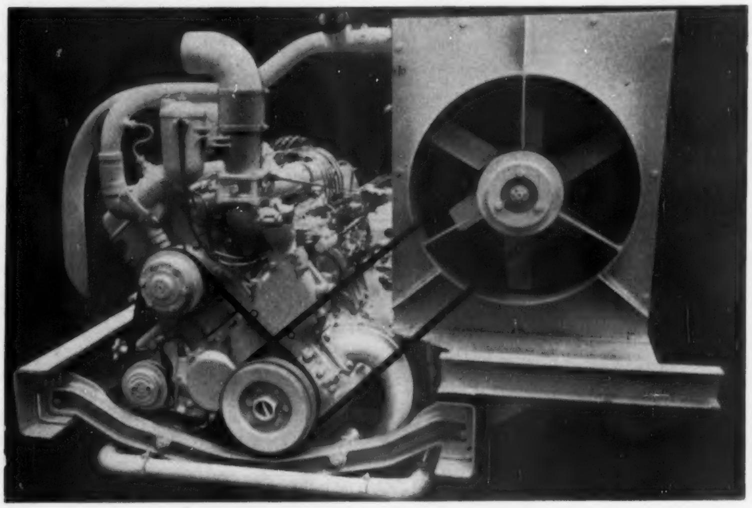


A Leyland 9·8 litre underfloor engine is carried at an angle of about 45 deg on six mountings in the Brossel A 95 DAR chassis

DAF military chassis

Military vehicle chassis are usually of considerable interest from the engineering point of view because they are designed for complete reliability under extremely adverse conditions. This operational requirement must be met almost regardless of cost. The DAF 3 ton, 6×6 chassis for military vehicles was certainly one of the most interesting displayed at Brussels. It is a six-wheel drive, cross country vehicle powered by a Hercules JXC, six-cylinder petrol engine developing 131 b.h.p. A 14 in diameter, single dry plate clutch is employed in conjunction with a four-speed synchromesh gearbox and two-speed differential.

A short shaft, with universal joints at each end, takes the drive from the gearbox to the differential unit. The drive is then transmitted by means of half shafts to a transfer box on each side of the differential. The half shafts are enclosed in flanged tubes bolted to the differential casing and to the



An interesting feature of the Brossel chassis is the fan, which has alternately long and short blades

transfer boxes. These transfer boxes are connected to the final drive units on the front wheels and to those on the foremost of the two rear wheels by means of propeller shafts incorporating universal joints at each end, and sliding joints. Another propeller shaft interconnects the two final drive units on the rear pair of wheels on each side. All the final drive units are identical and the gearing is of the worm and wheel type.

The front wheels, with their final drive units, are mounted on two parallel trailing arms, each of which is splined on to the outer end of a separate, transversely-mounted torsion bar. The torsion bars are enclosed in tubes, their inner ends are splined into a casting mid-way between the two suspension units, and the whole suspension assembly is mounted on a heavy cross member bolted up to the frame. The torsion bars are surprisingly short, but this is probably accounted for by the fact that they have a high rate. By employing two on each side, a useful safety factor has been introduced, in that a spring failure does not put the suspension unit completely out of action. Large diameter shock absorbers damp the suspension motion, and Ross ZF worm and nut type steering gear is employed.

The rear wheels and their final drive units on each side are mounted on the ends of parallel links, the centres of which are pivoted above and below an axle tube. Each end of this tube is carried on a semi-elliptic spring. Thus, the total load is distributed evenly between the front and rear wheels of each pair, since they are completely free to move in such a way as to conform with the ground profile over which they are running. A large diameter, telescopic shock absorber is mounted on each side between the axle and the frame. Two stout check-cables are fitted on each side to limit the rebound motion. The spare wheels are free to rotate on their mountings, which are positioned one on each side of the vehicle, between the front and rear driven wheels, at such a height that they prevent the chassis from fouling the ground when it is negotiating a ditch, mound, or other exceptionally severe obstacle.

The vehicle shown was for goods or personnel transport and weighs 8·84 tons. It is designed for a three-ton load and a two-ton towed load. Alternatively, it can be adapted to carry a two-ton load with a three-ton towed load. In this alternative form, it has a slightly smaller body and is fitted with a power winch bolted between the frame side members at the rear. This winch may be used if the towed load, a gun, for instance, has been dug in or is in soft ground. In these circumstances, the cable may be attached to the gun, which can then be hauled out of its position by means of the winch. The cable draws the towing eye into the towing attachment on the back of the vehicle, and when the two have engaged, the winch is automatically stopped. The winch incorporates a torque limiting device so that it cannot be overloaded. It may be operated with the vehicle on the move as well as stationary.

DAF bus chassis

The second new exhibit on the DAF stand was the B1500R bus chassis which weighs 3¼ tons and which is to go into production as an addition to their earlier range of models. This new chassis is available with a 17 ft 5 in or 19 ft wheelbase. It is powered by the Perkins R6 diesel engine which has six cylinders and a bore and stroke of 4 in by 4½ in. The swept volume of this engine is 5,560 cm^3, its maximum b.h.p. is 108 at 2,700 r.p.m. and the maximum torque is 240 lb-ft at 1,600 r.p.m. This engine was described fully in the October 1953 issue of *Automobile Engineer*.

A ZF, five-speed gearbox is employed, the fifth speed being an overdrive. All gears are of the constant mesh type, and the second, third and fifth pairs are helical. The drive to the rear axle is transmitted by a Hardy Spicer propeller shaft, which is supported by two intermediate bearings. Normally, a single speed axle is fitted, but a Timken two-speed axle can be supplied as an optional extra.

An all-welded frame is employed. It has straight channel section side members, 3 in wide over the flanges by 8 in deep by 8 mm thick. They are reinforced by closing plates welded to the edges of the flanges over the length above the rear springs. The top of the frame is flat throughout its length, and in the unladen condition its height above the ground is 35 in. All the cross members, of which there are seven behind the engine, are of channel section. Simple, semi-elliptic springs are employed for both the front and the

Rear suspension of the A 95 DAR chassis showing the local reinforcement of the frame

rear suspensions and telescopic shock absorbers are fitted at the rear only.

Light commercial vehicles

An unusual light commercial vehicle shown was the Tempo Ruthmann 1400. It is powered by the four-cylinder, four-stroke, 1,093 cm³ Heinkel engine which develops 34 b.h.p. The unusual feature of this vehicle is that its body can be lowered to the ground or lifted to any height up to about 52 in. This is particularly useful since loads may be wheeled or slid on to the floor when it is in the lowered position. It can then be raised to the normal position for transport, and on reaching the destination, it can be lifted or lowered to a suitable height for unloading.

In plan view, the frame is of Y-shape, with the cab, engine and front wheel drive arrangement represented by the leg of the Y, and the body suspended between the two arms. These two arms, or side frames, are parallel to each other and are fabricated from 3¼ in diameter tube. There are three horizontal tubes on each side, the lower one is about 14 in above the ground and is cranked beneath the rear suspension. The intermediate horizontal tube is about 16 in above the lower one, and the top tube is about 42 in above that. All three are spaced apart by a vertical tube at each end. In addition, a short vertical tube braces the lower pair of horizontal members adjacent to the pivot of the single, tubular trailing link of the rear suspension.

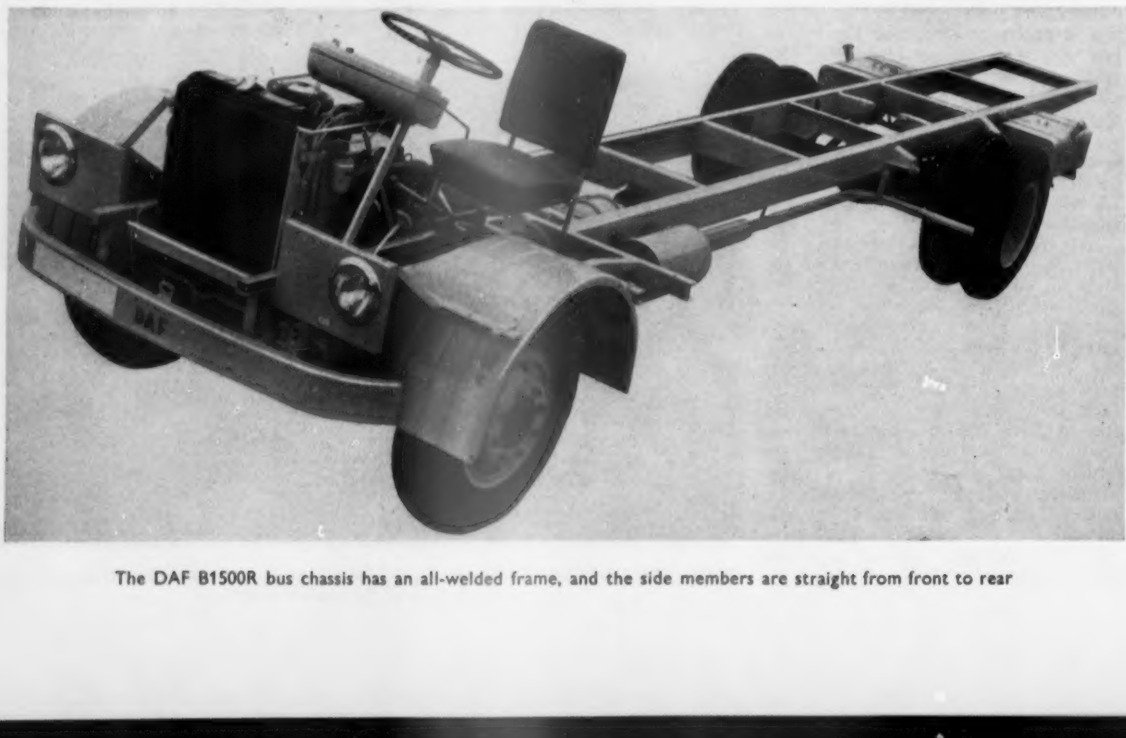
At the rear end of each trailing link immediately above the stub axle, two helical springs are in compression between the link and brackets on the intermediate horizontal member. A few inches further forward, a telescopic shock absorber is fitted. Two springs are employed instead of one so that they can be accommodated in the limited space available. The pivot of the trailing link is of exceptionally large diameter tube, because it has to react the couples due to lateral forces applied when the vehicle is cornering.

The Steyr 260 is based on the Fiat 615N chassis with semi-elliptic rear springs and coil type helpers

The body, which is designed to lift a load of 2,640 lb, is suspended on four cables attached to lugs, one at each corner. These lugs project into slots which extend the whole length of the vertical tubes at the front and rear. On each side at the rear, the cable passes up inside the tube, and over a pulley pivoted in a U-section gusset welded in the corner between the vertical tube and the uppermost horizontal one. It is then passed along the upper horizontal tube to a point just forward of the front vertical tube. Here, together with the cable which supports the front end of the body and which is carried up inside the front vertical tube, it is passed over a pair of pulleys and down in the control box. These pulleys are mounted in upward extension at each end of the control box, the main part of which is rectangular in section and extends the full width immediately behind the cab.

Positioned more or less horizontally in it is a single, large diameter, hydraulic jack with four pulley wheels on the end of its ram. The two cables supporting the corners on the right-hand side of the body pass under pulley wheels in the right-hand end of the box and then over two of four wheels pivoted on the end of the ram of the jack. These cables are doubled back under the jack, where their ends are attached to a bracket on the base of the control box. The two cables supporting the other side of the body pass under pulleys on the left in a similar manner to those on the right-hand side, but they are carried round an additional pair of pulleys mounted near the right-hand side of the box and above the jack; they are then brought back again over the remaining two of the four wheels on the ram. Their ends are attached in a similar manner to the same bracket as the other two cables. The additional pair of pulleys has, of course, been incorporated in the run of the cables from the left-hand side so that as the ram extends to the left, it pulls on these cables in the same way as it pulls on those from the right; likewise, as the ram closes to the right, all four cables are let out simultaneously.

When the body is in its normal position for transporting the load, it is supported on a pair of hooks at the front and on two bolts, one on each side, projecting to the rear from inside the lower horizontal tubes. These bolts register in slots cut in the lower edges of a pair of lugs extended outwards from the lower corners at the rear of the body. To lower the body to the



The DAF B1500R bus chassis has an all-welded frame, and the side members are straight from front to rear

On the DAF military tractor, the spare wheels are free to rotate on their mountings so that the vehicle may ride over exceptionally large obstacles without damage to the underside of the chassis

ground, it is first raised a little, then a lever at the front on the end of a transverse rod, on which are mounted the hooks, is pulled over. This rotates the rod and disengages the hooks and at the same time, by means of a cable control, draws the bolts into the lower horizontal tubes. The body can then be lowered on to the ground. The hydraulic jack is, of course, actuated by an engine-driven pump.

At the front, the lower horizontal tubes are separated by a cross member in front of which they are swept inward and then forward to carry the front suspension and engine. A double transverse link, independent suspension system is incorporated. The upper links are formed by a transverse leaf spring and the lower ones are of the conventional wishbone type. Telescopic shock absorbers are employed for damping.

It was of interest to note that a number of light commercial vehicles on the Fiat stand were powered by their 1,901 cm³ diesel engine. This unit has four cylinders with a bore and stroke of 82 mm by 90 mm respectively. The compression ratio is 20:1, and the maximum power developed is 40 b.h.p. at 3,200 r.p.m. A three-bearing, forged steel crankshaft is employed, and the overhead valves are actuated by push rods and rockers. The camshaft is driven by helical gears from the front of the crankshaft. Wet cylinder liners are fitted; they have a flange approximately midway between their two ends, where they seat in the block. Injection is effected into a swirl chamber in which is fitted a heater plug for cold-starting. The engine mounting system is similar to that employed on the Fiat private cars; that is, a V-arrangement of two large sandwich type rubber mountings is positioned somewhere near the centre of gravity of the engine and gearbox unit and a pair of coil springs is interposed between the rear extension of the gearbox and the frame cross member on which it is supported.

In the 615N chassis for light vans and pick-ups, the drive is transmitted to the rear wheels by a one-piece propeller shaft and a gearbox giving four forward speeds and one reverse. The rear suspension is of particular interest because a helper spring of the coil type is employed. In the laden condition, the lower end of the coil spring bears on a rubber pad on the plate for the U-bolts securing the underslung main spring, which is of the semi-elliptic type. The advantage of using a coil type spring is that only one bracket is needed on the frame to secure its upper end whereas, with a semi-elliptic helper spring, two brackets would be necessary. Telescopic shock absorbers, approximately 2¼ in diameter, are fitted.

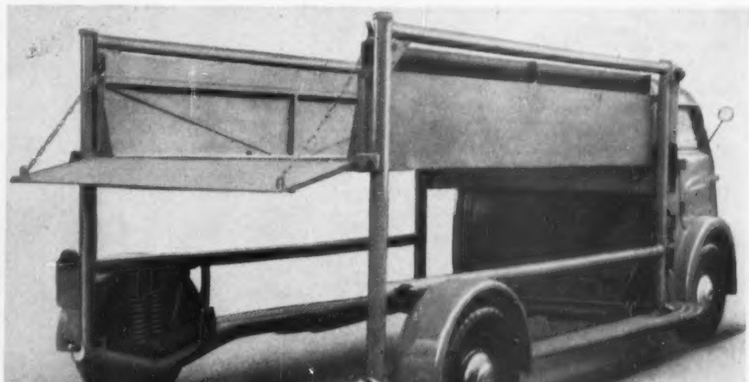
It is surprising that the general practice with vehicles of this type is to employ only one main spring. Two-rate, or increasing rate springs, would appear to be highly desirable at the rear on light commercial vehicles. Moreover, by employing the additional spring, it might in some cases be possible to make the main semi-elliptic spring common to the passenger cars and light commercial vehicles mounted on the same type chassis.

The frame is also of interest, because it is exceptionally well braced. Channel section side members are employed and one channel section cross member is fitted at the front. The independent front suspension is mounted on a large box section member bolted up to the frame, and immediately behind it is a cruciform bracing constructed of channel sections. The rear arms of the cruciform are attached to the frame immediately in front of the hanger brackets for the rear springs, between which is a box section cross member.

An unusual form of rear cross member is employed. It is a cruciform bracing, the front pair of arms of which are welded to the side members at the point behind the rear wheels where the arch above the axle joins the horizontal rear portion. The rear arms are welded to the frame immediately behind the bolted-on rear hanger brackets. A closing plate, in which lightening holes are punched, reinforces each frame side member between the two hanger brackets. This chassis is the basis of the Steyr light commercial vehicle shown in the illustration, but in this application it is powered by a petrol engine.

The overall dimensions of the vehicle are: length 14 ft 5 in, and width 6 ft over the rear wheels. The height of the top of the frame above the ground is 19¼ in. A wheelbase of 8 ft 8½ in has been adopted. The tyres are 6.00 by 16, and twin rear wheel equipment is employed.

Another interesting commercial vehicle displayed was the forward control, Goliath Express. It had a 15¾ cwt pick-up body. The unusual feature about this chassis is that it has the Goliath two-cylinder, two-stroke engine fitted with petrol injection equipment, mounted transversely under the driver's seat. In this position, it is immediately behind the transverse leaf spring suspension. The engine does not in any way obstruct the interior of the cab, while at the same time it occupies the least possible amount of length in the chassis. The drive, of course, is to



The body of the Tempo Ruthmann can be lowered to ground level or elevated to a height suitable for unloading

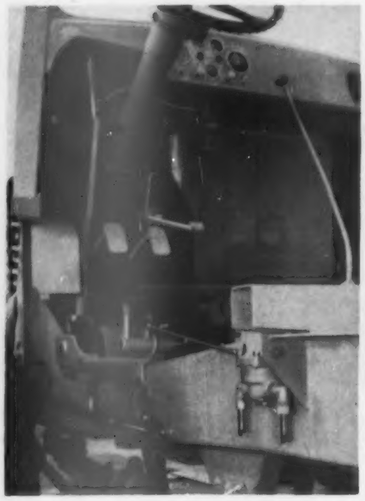
the front wheels; in fact, this installation is almost identical with that employed in the Goliath private car except that it is behind the wheel axes instead of in front of them, and therefore faces the opposite side of the vehicle.

The engine has a swept volume of 688 cm³, and its bore and stroke are 74 mm and 80 mm respectively. It has a compression ratio of 7·7 : 1, and develops 29 b.h.p. at 4,000 r.p.m. and a maximum torque of 48 lb-ft. Four forward speeds and one reverse are obtainable, and their ratios are: top 0·82 : 1, third 1·22 : 1, second 1·86 : 1, first 3·61 : 1 and reverse 3·50 : 1. The final drive ratio is 7·6 : 1.

A simple channel section frame with four main cross members, in addition to the front suspension mounting, is employed. As in the private car front suspension, the transverse leaf-spring forms the upper links of the system and a triangulated lower link is fitted on each side. At the rear, a conventional semi-elliptic spring and through axle arrangement has been adopted. It is damped by a pair of lever type shock absorbers. The overall dimensions of the vehicle are: length 15 ft, width 5 ft 9¼ in, height 5 ft 11 in. At the front the track is 4 ft 5 in, and at the rear it is 4 ft 1 in; the wheelbase is 8 ft 2½ in.

Together with the manufacturers of the Goliath vehicles, the Lloyd Motoren Werke are in the Borgward group, and their exhibits were all on the same stand. The Lloyd station wagon, which used to have a timber body, is now available in steel. In Britain this vehicle, which is a six-seater, would be considered grossly under-powered. It has a two-cylinder, two-stroke, air cooled engine, with a swept volume of 386 cm³, and it develops 13 b.h.p. at 3,750 r.p.m.

The overall dimensions of the vehicle



On the Unic vehicle, the preselector lever for the air control for the auxiliary gear train is mounted below the instrument panel

are: length 138·9 in, width 60·8 in, height unladen 63·7 in, and the wheelbase is 92·5 in and the track is 47·2 in. In the unladen condition, the total weight of the car is 1,311 lb; its permissible load is 1,334 lb. It is said to have a top speed of 43 m.p.h., and a cruising speed of 37 m.p.h.

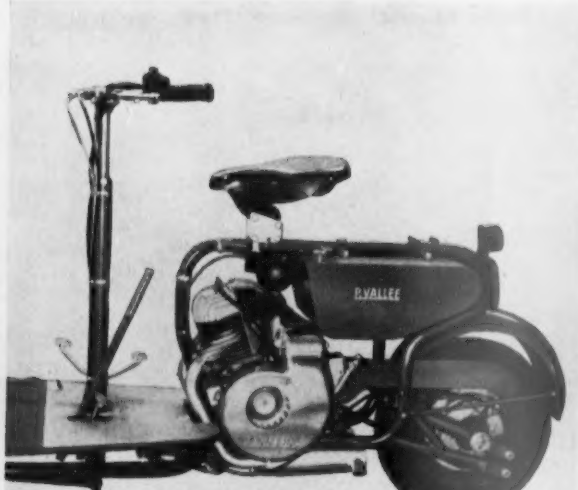
Probably the smallest commercial vehicles at the Show were the P. Vallee motor tricycles. The latest model is intended to carry a useful load of 880 lb. It is powered by the Hydral, 175 cm³, two-stroke, air cooled engine which develops 8 b.h.p. As can be seen from the illustration, the rear wheel is on a stub axle, overhung from a single trailing link. The spring is in the form of rubber bands round a pin in a fork on the end of the trailing link. These bands are anchored round another pin between two lugs on the end of a fixed arm below the trailing link. By mounting the wheel in this way, it may be removed easily for repairs to the tyre and tube.

The rear suspension is a double transverse link arrangement in which the lower links are formed by the transverse leaf spring, and the upper links are of the wishbone type. A tubular backbone forms the main frame member and a subsidiary member of U-shape is attached with the base of the U immediately in front of the engine and the arms trailing. The ends of the arms are welded to a short cross member supporting the independent suspension units.

Other features of technical interest

As is always the case at these Shows, there were innumerable details which were of interest to technicians. In some cases, the interest arises because the features are new and in others because they are unusual. The rear suspension of the Unic 10 ton chassis is unusual in that in the unladen condition, the ends of the helper springs bear against their brackets, while the ends of the main springs, which are in slider brackets, are sprung downwards on top of the pins that close the lower ends of the brackets. This means that the tops of the main springs are clear of the cast iron slider pads bolted in the brackets. The reason for this arrangement is obscure, for it would appear that it gives a single rate spring instead of the two rate obtained by the more conventional arrangement in which the helper spring only comes up against the brackets at each end when the vehicle is heavily laden or when the wheel moves up towards the full bump position.

Another interesting feature of this vehicle is the pneumatic control for the

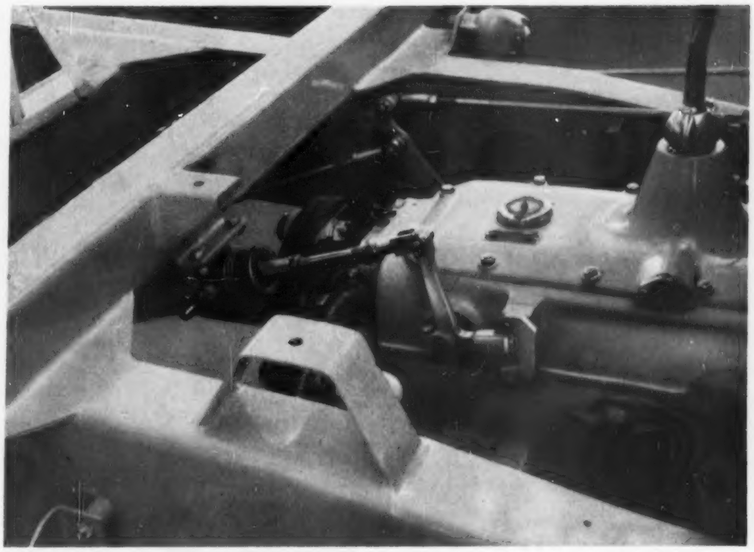


An interesting feature of the P. Vallee motorized tricycle, which is said to be capable of carrying a load of 8 cwt, is the rear suspension, the design of which makes wheel changing relatively easy

auxiliary gear train which, in conjunction with the five-speed box, gives ten forward speeds. The shift of the auxiliary train may be preselected by means of a hand lever immediately under the instrument panel. This lever operates a two-way, pneumatic control valve. When the clutch pedal is depressed, it actuates a small lever which bears down on a master valve mounted on the frame side member. This allows the compressed air to pass to one side or the other of a pneumatically operated jack bolted under the frame side member on the other side of the chassis. This jack actuates a two-position, bell-crank lever, gear shift control on the side of the gearbox. Once the change has been effected, the lever is held in position by a spring loaded plunger on the end of which is a wheel that seats in one of two semi-circular cut-outs in a quadrant bolted to the side of the gearbox.

A multi-pull hand brake of somewhat unusual design is fitted to this vehicle. There is a ratchet wheel on each side of the lever, and these wheels work in opposite directions. When applying the hand brake, the initial pull takes up the slack in the normal way, but to increase the braking force, the lever is pushed forward again. The mechanism is enclosed in a casting bolted to the frame and is arranged as follows: Fixed to the inner ratchet wheel, that is, the one nearest the centre of the chassis, are an annulus gear, which rotates in the casing, and the sprocket round which is wrapped the roller chain connected to the tie rod of the brake control system. Inside the annulus are three planet gears, the carrier of which is fixed to the casing. The sun gear is attached to the ratchet wheel on the other side of the hand brake control lever.

When the brake lever is pulled, a pawl engages the inner ratchet wheel, so that the annulus and sprocket are turned to take up the slack in the control. The movement of the annulus also rotates the planets, and causes the sun wheel and the other ratchet wheel to rotate in the opposite direction, but this subsidiary action has no effect since the pawl on this wheel rides over the teeth. However, when the lever is pushed forward, this pawl engages the teeth, and the sun wheel is turned and rotates the planets. This again rotates the annulus and further applies the brakes. The arrangement appears to work very well because of the additional mechanical advantage obtained when pushing the lever forwards. Nevertheless, it appears to be rather more complex than many of the other multi-pull hand braking systems displayed among the commercial vehicles.



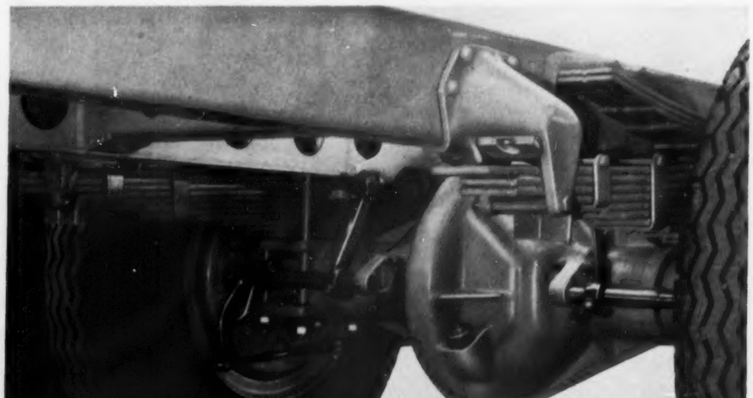
A pneumatic jack actuates the two-position bell crank control for the auxiliary gear train of the Unic chassis

The frame of this vehicle is of all-welded construction and all the main side and cross members are of box section. The side members are formed of channel sections closed by a plate welded between their flanges. Lightening holes are punched extensively along the length of this plate. Behind the engine, there are four main cross members, which are box sections fabricated by welding two channels together. These members are again lightened by holes punched in their vertical walls. An additional cross member is fitted at the extreme rear of the frame, but it is of channel section.

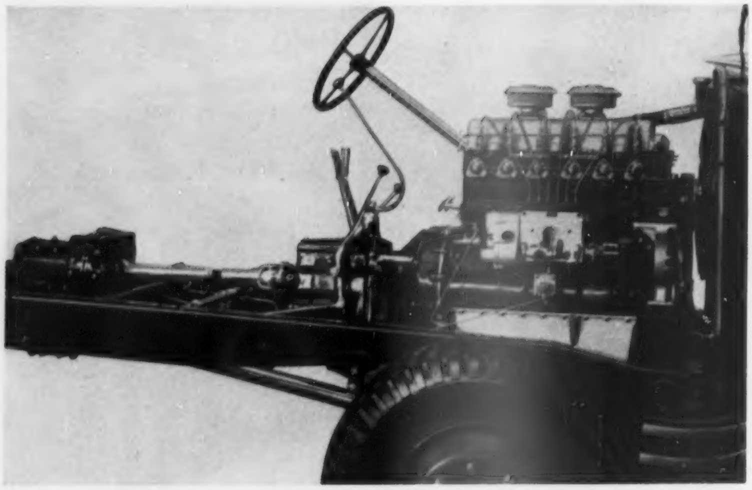
This frame must be exceptionally stiff torsionally, a feature that is not favoured by all manufacturers. In many quarters it is thought better to allow the frame to deflect freely, so far as what is commonly known as "weaving" is concerned. However, it is sometimes argued that when welded construction is employed, extensive deflection of one side member relative to the other would cause fatigue failures at the junctions between the cross members and side members. These failures are said to occur because of the relative inflexibility of welded joints as compared with riveted ones.

There were one or two modified chassis on the Borgward stand. One, the B4553, has forward control. This modification has been effected simply by mounting the pedals and steering gear on a large bracket bolted to the frame side member in front of the front wheels. The gear shift lever has been re-shaped so that its upper end is in a position conveniently reached by the driver.

The mounting arrangement for the engine of this vehicle is in conformity with the modern trend in that it is relatively flexible. A conventional



On the rear suspension of the Unic chassis the ends of the helper springs are in contact with their brackets, even when the vehicle is unladen



The transmission brake fitted to the two-speed transfer box of the Borgward B4500 chassis is the same as that used in the B4553 unit

V-arrangement of two sandwich type units is employed at the front, while a double vertical sandwich is fitted on each side of the gearbox casing at the rear. The central steel plate carries the engine, and the two outer ones are attached to the frame. A two-speed auxiliary box, mounted between the frame side members just forward of the front eyes of the rear springs, is controlled by a lever carried on the frame side member immediately behind the bracket for the forward control assembly. Bolted to the rear of this two-speed auxiliary box is a transmission brake. The same type of brake is bolted to the front of the two speed transfer box of the Borgward B 4500, which is a four-wheel drive chassis. All the Borgward vehicles have lever type shock absorbers on all four wheels.

There were one or two noteworthy features to be seen on the Volvo B 727 chassis. This vehicle has a wheelbase of 17 ft, the front track is 5 ft 11¼ in, and the rear track is 5 ft 7¼ in. Its overall length is 32 ft 6 in, and the rear overhang is 10 ft 1¼ in. With a bare chassis, the weight carried by the front wheels is 2¾ tons and that carried by the rear wheels is 1·57 tons; thus the total weight is 4·32 tons. It is designed for a maximum all-up vehicle weight of 11·8 tons.

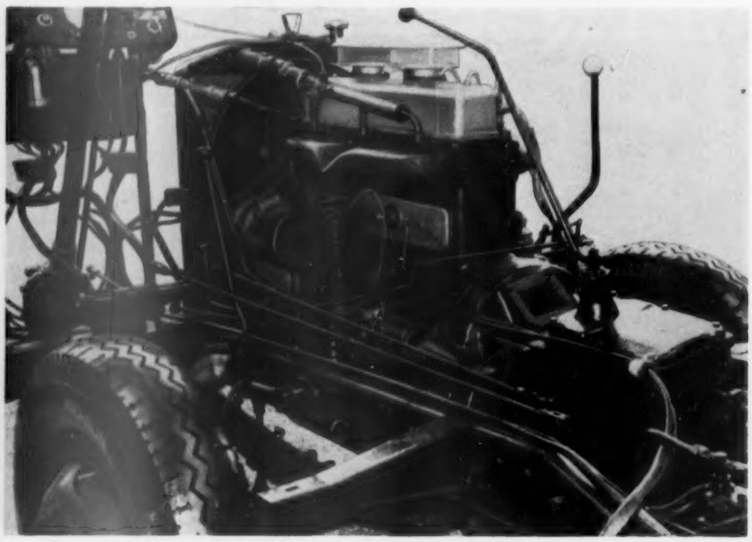
The reinforcement of the frame where it is arched over the rear axle is an example of good design. Each channel-section side member at this point is closed by a plate welded to the flanges. The ends of the plates are bent into the channel and welded to the inner face of its vertical wall. In this way, the vertical loads from the telescopic shock absorbers, which are on brackets bolted to the closing plates, as well as those due to the arching of the frame, are transferred to the vertical walls of the side members.

On a number of chassis displayed by other manufacturers, the closing plates used for reinforcing the side frames over the rear springs were not attached at their ends to the vertical walls of the channel sections. In this case, the tendency is for the vertical loads to bend the flanges of the channels and cause fatigue failure. The fact that fatigue failures are not experienced in all such cases would seem to be an indication that the frame is heavier than it need be if the ends of the closing plates were properly secured.

The rear suspension of the Volvo 18 ton truck is worthy of note, not because it is new, but because it is representative of a relatively simple method of converting a four-wheel truck into a six-wheeler. An additional axle, which is not driven, is mounted behind the rear axle. It is carried on and bolted to two malleable cast brackets, which have their upper ends shouldered to fit between two closely spaced, frame cross members. A lever of large cross section is centrally pivoted on each end of the axle tube. Suspended from the front end of this lever is the rear shackle of the spring for the driven axle. Formed on the rear end of the lever is a boss in which is carried the stub axle for the additional wheel hub. In the full bump position, the rear end of the lever comes up against a rubber stop mounted under the frame side member.

Another rear suspension arrangement of interest was that on the Berliet PCR10 coach chassis. The Gregoire system is employed, and an anti-roll bar is incorporated. On each side, the brackets supporting the semi-elliptic spring, which is underslung beneath the rear axle, are welded to the underside of the frame side members and are extended towards the axle to carry the pivot mountings for the two horizontal coil springs. The other ends of these springs are each on a carrier pivoted between lugs on the axle. To provide clearance for these springs at the full bump position, the frame side members are arched to an unusual extent. These members are of channel section and each is reinforced by a closing plate welded to their flanges. The ends of the anti-roll bar are pivot mounted in two brackets bolted to the closing plates. Adjacent to these brackets are levers attached to the bar, and a drop link connects the ends of these levers to the spring retaining plate. Telescopic shock absorbers are fitted.

A conventional semi-elliptic spring-and-helper type rear suspension is employed on the MAN F8EL but, as can be seen from the illustration, a somewhat unusual rear-end frame construction has been employed. The problem that has generally to be faced in frame design is, of course, to make the frame wide enough to support the



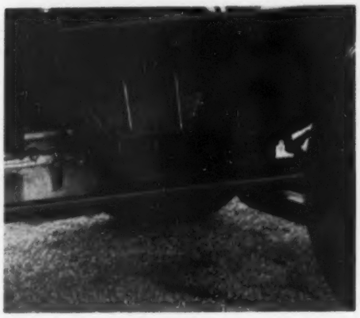
Modification of the Borgward bus chassis to provide forward control has made possible the introduction of five extra seats in the body

body and to accommodate the engine and other mechanical components, while at the same time not so wide as to make the wheel track unduly large. Most manufacturers crank the frame inwards, simply by bending it, to provide the necessary clearance for the wheels. In these circumstances, it is highly desirable, but not always practicable, to incorporate a cross member at each bend of the cranked frame. If the bends are not supported in this way, there is a tendency for unduly high stress concentrations to occur in the flanges and the adjacent areas in the webs. These stresses can be offset by the use of relatively thick material for the side members but this, of course, increases the weight.

On the M.A.N. chassis, the main portion of each side member terminates in front of the rear wheels and the adjacent spring hanger brackets are secured to the ends of these members. The extension of the frame to the rear is effected by means of two more channel sections which are reinforced over the length of the suspension by a closing plate welded to the flanges, and which are positioned between the rear springs. The front ends of these extensions are turned outwards and bolted to the inner face of the vertical walls of the main side members, and a cross member provides additional support between the side members at this junction. Another cross member, extending over the whole width of the frame, joins the rear ends of the main side members and the subsidiary members at the points where they are bent outwards. This might be criticized as being somewhat complex but it is, nevertheless, an extremely sound construction.

From the illustration of the Miesse chassis, it can be seen that bolted-on cross members are employed to carry the Gardner GHLW underfloor engine and a ZF, six-speed, electrically controlled gearbox. The remaining cross members on this frame are riveted on. At the rear, the side members are cranked inwards to clear the wheels and, although a cross member supports the bend at the front end of the crank, the other cross member has had to be positioned some distance to the rear of the bend in order to clear the gearbox.

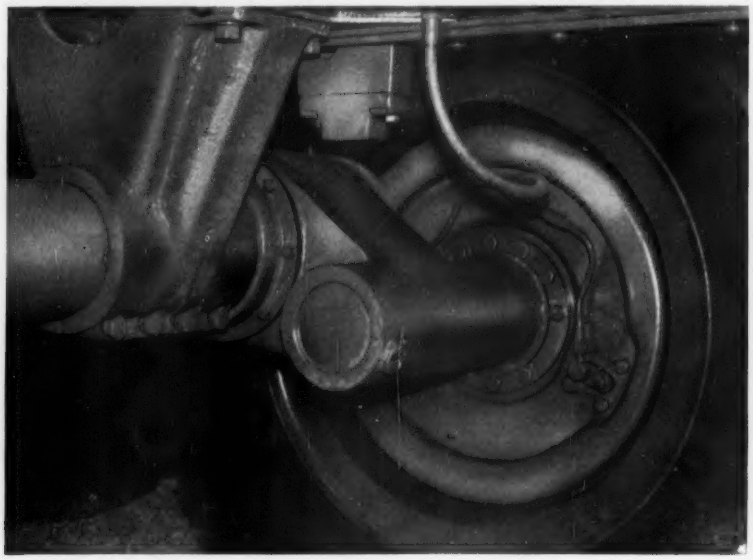
With the Volvo suspension arrangement, conversion from a two-wheel to a four-wheel rear layout is relatively easy



In a number of Miesse chassis, the spring ends are carried in rubber blocks

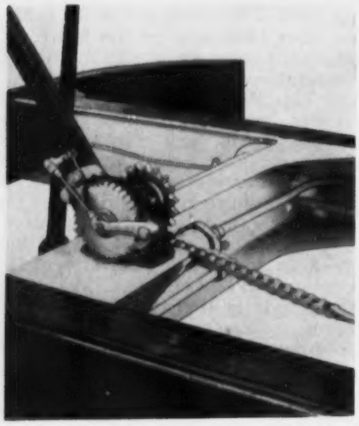
In this Miesse chassis, as well as in another powered by the Gardner vertical engine, both ends of each of the semi-elliptic springs are carried in rubber mountings. As can be seen from the illustration, the housings for these mountings are unusually large. The rubber blocks are of C-shape, and the ends of the two top leaves of the spring project into the C. On each of these ends is riveted a pressed steel fitting, the longitudinal section of which is of bulbous shape. Thus, it fits inside the rubber block, so that changes in the length of the spring during flexure are accommodated by the elasticity of the rubber instead of by sliding between the ends of the leaves and the rubber. In addition, these end-fittings form stops to locate the springs longitudinally.

The hand brake on the underfloor engined chassis is another example of a multi-pull arrangement. As can be seen from the illustration, it is mounted on a bracket on the frame cross member. A ratchet pawl, pivoted on the bracket, locks the ratchet wheel after it is turned by the brake lever, on which is another pawl. To release the brake, a thumb control on the end of the lever is pressed and it disengages the pawl on the bracket. The brakes may then be released gradually by allowing the lever to come slowly forward. When it reaches its extreme forward position, a lever extension of the pawl which is pivoted on the hand brake control strikes the stop and disengages the pawl, thus releasing the brakes completely. Another interesting feature of this control is that the sprocket, round which is wound the roller chain secured to the brake operating rod, is eccentrically mounted in such a way that the initial slack is taken up quickly, but as the load becomes greater, the mechanical advantage obtained is increased.



A view of the back of the Volvo rear suspension arrangement

A somewhat unusual frame construction has been adopted in the M.A.N. F8EL chassis



The multi-pull hand brake on the Miesse chassis

The White We28D truck and the We28PLTD tractor chassis have a suspension arrangement which is unusual for vehicles with only one pair of rear wheels. Each end of the semi-elliptic springs is pivot mounted at the upper end of a shackle, the lower end of which is carried in the usual way in a bracket overhung from the frame side member. The unusual feature is that positive location of the axle is effected by means of a radius rod on each side. Each end of the rods is ball-jointed, their upper ends being mounted on brackets riveted to the frame side members and the lower ends are carried by the plates for the U-bolts securing the springs. The radius rods are approximately 37 in long and are made of 2½ in diameter tube, and the springs are about 53 in long.

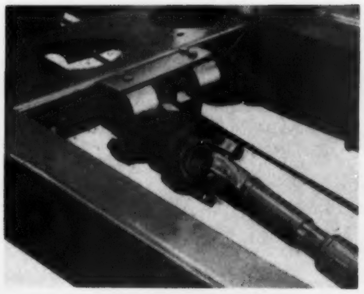
Another truck chassis has been added to the Henschel HS100 range. It is the HS100E and is similar to the earlier models, but the price has been reduced by 9 per cent by eliminating the two-speed auxiliary box. Therefore, five speeds instead of ten are now available. In addition, there is now no differential lock, and the cab is rather more austere. This does not mean that the cab is in any way poorly equipped; for more amenities were provided in the earlier models than is usual in trucks designed for short and medium haulage. As is well known, the Continental manufacturers produce trucks for very long distance runs, which may take a fortnight or more to complete. In these circumstances, crew comfort is of considerable importance, but for shorter runs, the additional cost of many amenities provided in cabs for long distance work is not justified.

Another exhibit on the Henschel stand was the HS100N coach chassis which differs from the HS100UN in that the engine, instead of being under the floor, is mounted transversely at the front. With this arrangement, most of the engine components are readily accessible and it has been possible to incorporate an extra door ahead of the front wheels of the vehicle. The hand brake lever is mounted on the left of the driver's seat, so as not to obstruct the passage from the door to the passengers' seats.

The engine is the Henschel 512DJN2 diesel unit. It has six cylinders, each with a bore and stroke of 96 mm and 125 mm respectively. This gives a swept volume of 5,429 cm^3. The power developed is 100 b.h.p. at 2,400 r.p.m., and the maximum torque is 239 lb-ft at 1,300 r.p.m. A conventional propeller shaft, with an intermediate bearing, transmits the drive from the five-speed AK5-33 gearbox to a two-speed auxiliary box at the centre of the frame. From the auxiliary box, another propeller shaft, incorporating a sliding joint, transmits the drive to the rear axle, which is fitted with a differential lock. The frame is of exceptionally rigid construction. It incorporates ten cross members braced by channel section diagonal members which, together with the box section side members, form a structure similar to an N-braced beam.

A simple, semi-elliptic suspension system with telescopic shock absorbers is employed both at the front and at the rear. At the front, the track is 74¾ in, while the rear track is 76¾ in, and the wheelbase is 177 in. The overall length of the chassis is 31 ft 4 in and the height of the top of the frame above the ground when the vehicle is laden is 28 in. A turning circle of 31 ft radius is obtained, and Ross worm type steering gear is employed. The weight of the chassis is 8,400 lb and the total permissible all-up vehicle weight is 24,700 lb. On each axle, the maximum permissible load is 12,350 lb. For long distance travel, seating accommodation is provided for 51 persons, but for urban services, 33 seats are

The Gregoire suspension system, with an anti-roll bar, is employed in the Berliet PCR10 chassis



The simple flexible mounting for the intermediate bearing on the Mercedes Benz L5500

provided and 38 standing passengers may be carried.

Transmission brakes are still popular on the Continent. On the Scania Vabis B51 bus chassis, a Bendix, drum type brake, with internally-expanding shoes, is mounted on the rear end of the gearbox. The Citroen 55, like the Borgward vehicles already described, has a disc type brake. The disc is a casting comprising two pressure plates separated by radial ribs. Centrifugal action causes air to flow outwards between the two discs, and assists in cooling the unit. External shoes, or brake bands, are also popular on transmission brakes, but the magnetic type has not yet been widely adopted. Another interesting feature among the transmissions was the simple flexible mounting of the intermediate bearing for the propeller shaft of the Mercedes Benz 5500. This is shown in the accompanying illustration, which is self-explanatory.

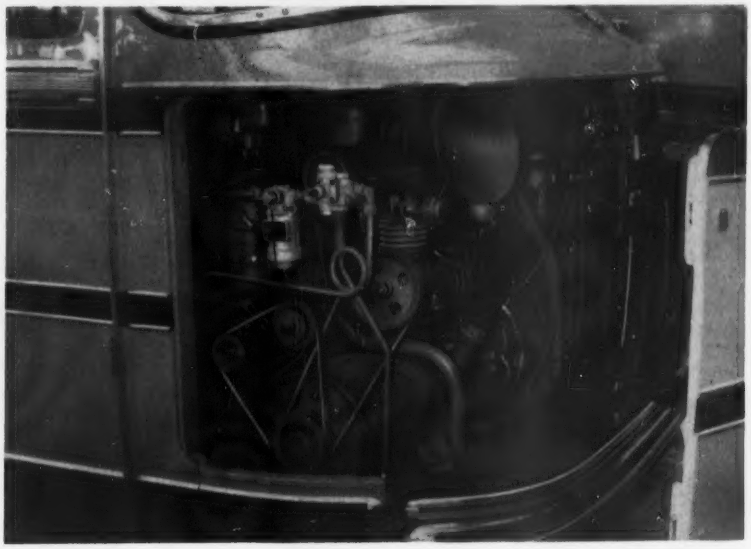
Engines

To meet the increasing demand for larger engines for commercial vehicles, Klockner Humbolt Deutz A.G. have introduced a new air-cooled engine which was displayed on the Locorail stand. This is a 15,966 cm^3 V-twelve unit, which develops 230 b.h.p. and weighs 2,750 lb. Thus, it weighs 11·9 lb/b.h.p. and develops 14·5 b.h.p/litre. It is now one of the most powerful air-cooled engines manufactured anywhere in the world for application to road vehicles. Although air-cooled engines have a reputation for being noisy as compared with water-cooled units, the Deutz engines are employed on the continent not only for bus services, but also for some long distance coaches.

The bore and stroke are 110 mm by 140 mm, and are the same as in the remainder of the Magirus Deutz range. Thus, the cylinders, connecting rods, pistons and many other components are common to this engine and the 8, 6, 4, 3, 2 and single cylinder units. The development problems associated with the design of large air-cooled engines are formidable; for instance, uniform cooling is difficult to achieve, and the blower design alone could almost be described as a lifetime's study. However, most of the initial development work for this range of engines was carried out during the years 1935-1942, and it would appear that the manufacturers are satisfied that they have solved most of the outstanding problems. They have certainly gained a long lead over any newcomers who might venture to enter into competition with them in this field.

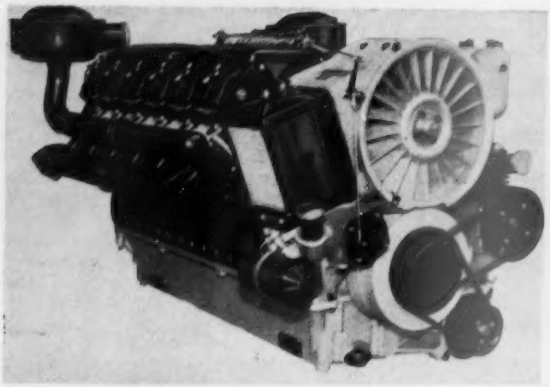
The stroke of the Scania Vabis engines has now been increased to 150 mm, while the bore remains at 115 mm. With four cylinders, this gives a swept volume of 6·23 litres. The compression ratio is 16:1. The maximum power of 100 b.h.p. is developed at 2,200 r.p.m., and the maximum torque of 278 lb-ft is obtained at slightly more than 1,000 r.p.m.

An integrally cast, chromium iron cylinder block and crankcase is employed. Centrifugally cast, wet liners are fitted. The alloy iron cylinder heads are cast in pairs to help to eliminate distortion troubles and for ease of servicing, as well as to make the heads common to a range of engines. Replaceable caps are fitted over the ends of the chromium plated stems of the valves, which are Stellite faced. To obtain good breathing characteristics, the outer ends of the induction ports are not of circular

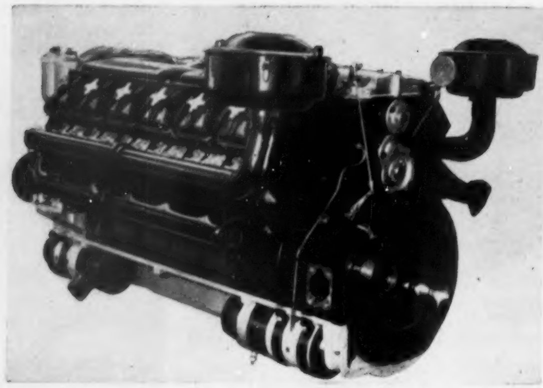


A noteworthy feature of the Henschel HS100N coach is the accessibility of the engine, which is transversely mounted at the front

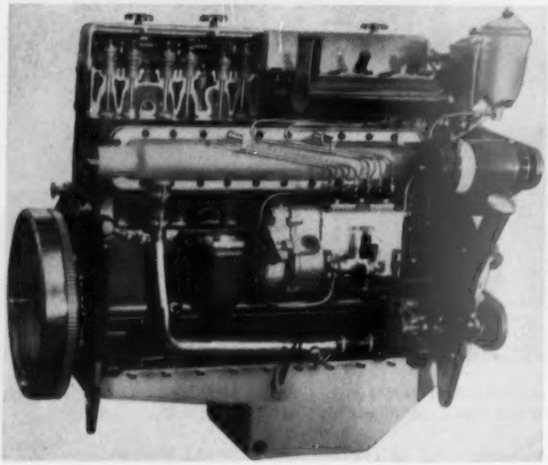
Detachable cross members support the Gardner GHLW engine and ZF gearbox in the Miesse chassis



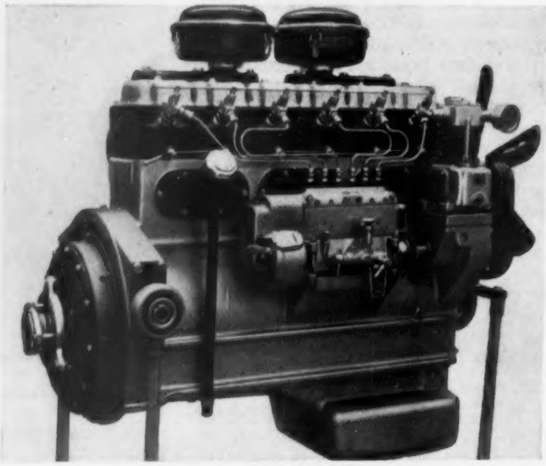
A large blower is employed on the air-cooled Magirus Deutz V-twelve engine to serve the cylinders and an oil cooler



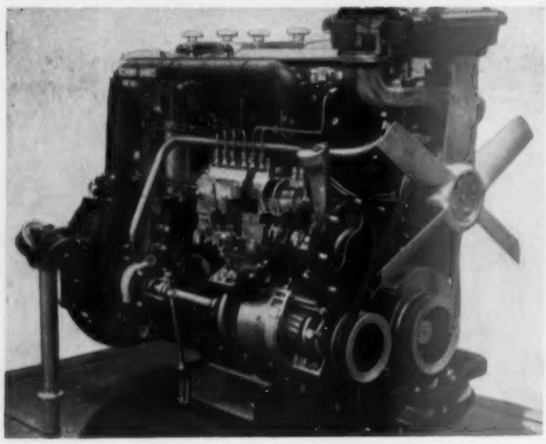
Compactness is an outstanding feature of the Magirus Deutz V-twelve engine which is only 2 ft 10¾ in high



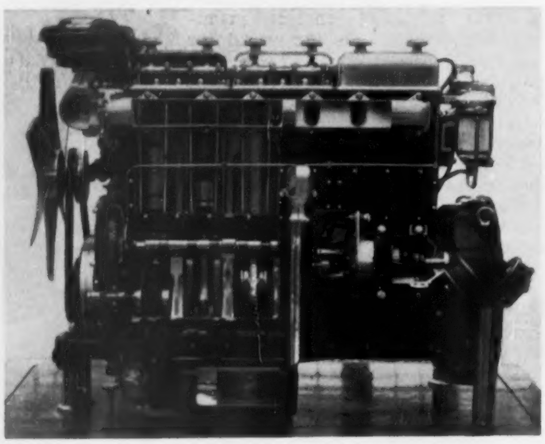
This M.A.N. engine has a water-jacketed cabin heater tube bolted to the side of the block and the air inlet is behind the fan



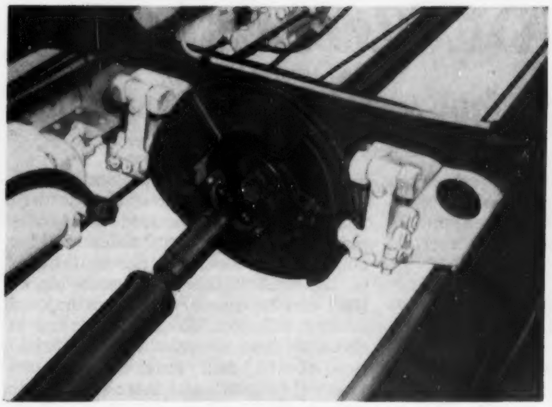
The cylinder heads, liners, pistons and connecting rods of this six cylinder engine are common to the whole Steyr range of power units



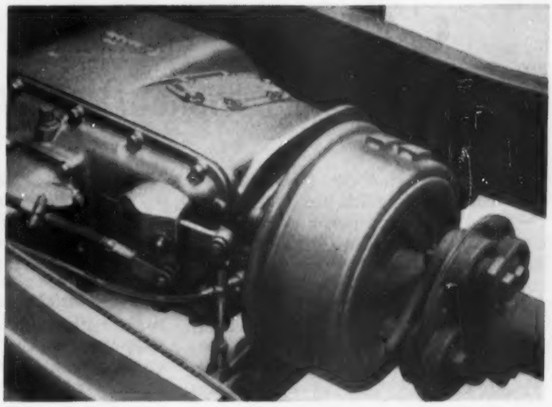
On the Scania Vabis engine, the water pump is driven in tandem with the generator



The outer ends of the induction ports on the Scania Vabis unit are of oval cross section



A disc type transmission brake, with radial slots in the disc for air cooling, is employed on the Citroen 55



The internally-expanding-shoe type transmission brake on the Scania Vabis B51

section, but are of oval form with their major axes vertical. Thus, as the column of incoming air sweeps round the elbow it tends to become of circular section and passes into the cylinder through the whole of the area enclosed by the valve seat.

The crankshaft is an alloy steel forging and the five main journals, as well as the big ends and the fully floating small ends, are fitted with indium flashed, lead-bronze bearings. A somewhat unusual torsional vibration damper is employed. It consists of two heavy, circular plates, between which are coil springs in compression, and the whole unit is enclosed in a steel housing bolted to the crankshaft. Interposed between the plates and the housing are rubber discs, so it would appear that this is a combination of the spring-mass type and the friction type damper arrangements. Aluminium alloy pistons with three compression and two oil control rings are employed. The top ring is chromium plated to reduce cylinder wear.

Three bushed bearings carry the forged camshaft which is driven by helical gearing from the crankshaft. The C.A.V. injection pump is driven in a similar manner and is regulated by a pneumatic governor. Multi-hole injection nozzles are employed. A gear type oil pump, used in conjunction with a piston type relief valve, serves the lubrication system. The sump capacity is 2·64 gallons. A centrifugal type water pump is driven in tandem with the generator; it has a stainless steel spindle and a rotor of corrosion resistant phosphor bronze. The radiator has a capacity of 5¾ gallons.

Only the six cylinder version was shown sectioned on the stand, and it is that which can be seen in the accompanying illustration. A somewhat unusual engine mounting system has been adopted. Six circular rubber sandwich type mountings are employed; two form a conventional V-arrangement at the front, and two on each side at the rear support a bracket bolted to the flywheel housing. These rear mountings are each arranged with their axes inclined to form a Vee in a longitudinal plane, so that they provide positive fore and aft location. This system has the advantage that all the rubber units are identical, but it is doubtful if the rear mountings are as effective as a double vertical sandwich would be.

Externally, the M.A.N. diesel engine appears to be the same as earlier models. However, the combustion system and injectors have been modified to form what the manufacturers term the "M system." This modified arrangement is said to have made the engine quieter in operation, easier to start from cold, and to have improved the brake specific fuel consumption.

Previously, the spherical combustion chamber was incorporated eccentrically in the piston crown. However, to improve the temperature distribution, it has now been centralized. Moreover, the opening in the piston crown has been enlarged, so that there is no danger of its edges overheating or burning. The underside of the combustion chamber is cooled by two jets of oil from the top of the connecting rod. The jet holes are arranged so that they communicate alternately with the oil supply, and direct the oil to opposite sides of the exterior of the combustion chamber under the piston crown.

Shrouded inlet valves are employed to induce the necessary swirl action in the incoming air, and a two-spray injector is fitted in the head. The nose piece of the injector is of conical form and is pulled against a conical seating cut in the head. This forms a gas-tight seal, and at the same time, the smallest possible area at the end of the injector is exposed to the hot gases. In this position, the injector is as far as possible away from the combustion chamber, and is well cooled.

To prevent distortion of the injector when tightening it in its housing, a compression spring is interposed between a shoulder on the body and the nut that is screwed into the upper end of the housing to secure it. Thus, differential rates of thermal expansion of the housing and the injector cannot overstress the unit and cause distortion. The spring is simply a steel sleeve, the periphery of which is slotted. These slots are in planes at right angles to the axis of the sleeve, and are in diametrically opposed pairs, each pair being positioned 180 deg from those above and below it.

A new engine developing 150 b.h.p. was shown on the Steyr stand. It is a six-cylinder unit, the cylinder dimensions of which are the same as the four-, two- and single-cylinder engines. Thus, the liners, pistons and connecting rods, as well as the separate cylinder heads, are common to the whole range. The engine mounting system is unusual. At the front, a horizontal rubber sandwich unit, mounted on a bridge piece bolted to the chassis frame, is positioned between the driven pulley of the dynamo and the driving pulley of the compressor. This rubber unit is longer than usual so that its width is small enough to be accommodated between the fan and timing cover. The advantage of using such a high point is that the amplitude of motion is small, so that a relatively thin sandwich unit can be employed.

On each side at the rear, a plain, rubber-bushed trunnion is bolted to the side of the flywheel housing. This arrangement would appear to give equal stiffness in all directions in the longitudinal vertical plane. Possibly a slotted bush of the Metaxentric type would be better in this application, since it could be arranged so that the vertical stiffness is less than that in the fore and aft direction.

FORTHCOMING ISSUES

The next major automobile exhibition, the Geneva Show, will be reviewed in the April issue of this journal. In this review, major attention will be focused on passenger cars, with particular attention paid to bodywork.

Full technical descriptions of the new Standard "Eight" and the Citroen 2CV will appear in early issues, which will also include a full description of a new back axle testing machine developed by Heenan and Froude Ltd. for British Timken.

CARBON DIOXIDE COOLING

The Application of the CeDeCut Technique to Machining Operations

CARBON dioxide (CO_2) as a cooling medium for machining operations has not, until recently, been completely satisfactory in practice. Hitherto it has generally been applied in much the same way as the conventional liquid coolants and consequently its special properties have not been used efficiently and economically. Now, after considerable research, the Carbon Dioxide Company Ltd., in collaboration with the Central Research Department of The Distillers Company Ltd., have developed a special technique, known as the CeDeCut, for using CO_2 as a coolant for machining operations. This technique particularly merits the attention of those concerned with the working of high-strength materials, which, in general, present the most difficult machining problems.

CO_2 is most conveniently delivered to a machine in the form of liquid under pressure. Its essential importance as a tool coolant derives from the fact that, when expansion of the liquid to the atmosphere by flash evaporation converts part of it to gas, the consequent reduction in temperature converts a further portion to a "snow" of solid CO_2, which at atmospheric pressure exists at a temperature of −78 deg C. Under these conditions the solid then sublimes directly into gas. For every pound of solid that is thus gasified 250 B.T.Us of heat are removed from the surroundings. Very high rates of heat removal are obtained when, by suitable control of the liquid CO_2, the solid form is produced and projected on to a restricted area of hot surface.

Points of application

In earlier attempts to use the properties of carbon dioxide for low temperature cooling, jets of liquid CO_2 were directed towards tool cutting surfaces in the conventional manner. It was found that the cold, finely divided "snow" that was formed cooled everything with which it came in contact. In some cases the cooling effect was sufficient to allow higher machining rates to be employed with increased tool life.

In general, the results suggested that carbon dioxide might prove to be a successful coolant for the newer metals and alloys used in jet engines and for the tough, high tensile steels now so widely used. It was soon realized that a completely new technique was necessary if the properties of CO_2 as a coolant for machining operations were to be exploited to the full. After preliminary trials, it was decided to develop methods whereby the "snow" is directed:—

(1) towards the point where the cooling effect is most needed, the tool point;
(2) away from the turnings or chips, where the maximum possible temperature is normally desired; and
(3) towards the workpiece, to cool it where necessary.

Machining applications

Probably the most immediate use of CO_2 as a tool coolant is in some of the applications which are usually effected by dry turning. Fundamentally, the rate of metal removal in dry turning is governed by the resistance of the tool tip to the forces acting on it, and all tool tips, whatever their composition, weaken more or less rapidly with increase in temperature. In dry turning, tool tip temperature rises as the surface cutting speed is increased until eventually a temperature may be reached at which the tool tip life will be seriously shortened. At the same time it is advantageous to operate at a speed that will cause sufficient heat to be generated to soften the chip.

Dry turning may therefore involve a certain compromise in cutting conditions between the speed for optimum tool life and the speed to generate the required heat in the chip. If, however, CO_2 cooling is employed, it is possible to operate at a speed at which the heat generated will soften the chip and at the same time apply intense local cooling to the tool tip. Tests have proved that the application of this technique will allow much higher cutting speeds to be employed, with greatly increased tool life and a better quality of finish on the work.

It is not suggested that Co_2 cooling should be adopted for all turning operations. For example, there are many turning operations in which tool tip temperature is not the controlling factor, and conventional fluids will provide adequate cooling. Where the tool tip temperature is the limiting factor, solid CO_2 at a temperature of −109 deg F, applied near to the cutting edge, must give a lower temperature than can be obtained with cutting oils or emulsions. In such applications, CO_2 cooling may give the following advantages:—

(1) Lower tool tip temperature, and hence higher permissible tool speeds and longer tool life.
(2) No contamination of stock or swarf. Therefore there is no necessity for degreasing after machining.
(3) Freedom from oil fume contamination of the atmosphere.
(4) The wearing parts of the machines can be lubricated as required without contamination of the lubricants by cutting oils or soluble emulsions.
(5) The operator has an unobstructed view of the work.

CO_2 can be usefully applied in normal drilling operations by discharging a jet to just above the point of entry of the drill. Solid carbon dioxide then adheres to the drill outside the workpiece. The temperature differential for conduction of heat from the cutting face of the drill is therefore much higher than can be obtained by conventional cooling. Carbon dioxide employed in this way does not provide any lubrication of the drill flutes to facilitate removal of swarf, and there are definite limitations to its practicability.

In vertical end milling, the application of CO_2 is similar to that employed in drilling. The knowledge at present available suggests that the primary advantage in vertical end milling is that it allows dry machining to be carried out at a range of feeds and speeds hitherto not practicable. For example, high speed milling with CO_2 cooling are giving three times the normal rate of metal removal from materials such as Nimonic 80.

For surface milling, where the size of the milling cutter may be large in relation to that of the cutting edge in contact with the work, cooling by CO_2 may result in a large proportion of the coolant being dissipated wastefully through the cutter arbor and elsewhere. A modified system of coolant supply is now being investigated. In this system light oil is used to weight the CO_2 snow so that it can be projected on to surfaces that otherwise it would be difficult to reach. The function of the oil is not that of a conventional coolant.

Tool grinding

Carbon dioxide cooling can also be very effective in tool tip grinding. The jet or jets of coolant maintain the tip at normal room temperature or lower. As a result the risk of thermal cracking is completely eliminated, as is also the weakening of the bond between the tool tip and the tool shank. The CO_2 leaves the grinding wheel clean and dry. In addition there are no residues of coolant to clog the wheel, and the cooling can be so directed as to maintain the wheel at normal or sub-normal temperature; this helps to preserve the resin or other bonding material.

There is not sufficient information to allow generalizations on the economics of CO_2 cooling, but it does appear that for certain applications it can lead to direct economies. For example, in dry turning of high-tensile steel it was found that the use of CO_2 allows at least a two-fold increase in cutting speed with a two-fold increase in tool life. There is also the possibility of indirect economies. For example, there is the elimination of degreasing operations, the possibility of clean swarf for recovery and the elimination of oil fume nuisance from high speed machines.

MECHANIZED ASSEMBLY

American Developments for Stud and Nut Running

IN general, the mechanization of assembly functions has lagged behind that of other production processes, but there is now a tendency towards developing machines specifically for assembly operations. Such machines are usually designed to fulfil two objects. The first is to improve the standard of work quality by making the maintenance of product standards a function of the machine instead of a matter that is in part, or whole, dependent upon the skill and care of operators. Secondly, these machines are designed to reduce unit costs by greatly reducing the amount of labour required for a given output.

Basic principles

Of the American developments in this field, some of the most interesting are the automatic nut-torquing machines designed by Hautau Engineering Company, Detroit, Michigan. These Hautau developments are hydraulic powered multiple spindle machines that will automatically tighten a nut or bolt to a given torque specification, tighten a bolt to a specified elongation or drive a stud to a given depth. They also act as gauging machines, since individual spindles will not drive bolts, studs or nuts if their thread fits exceed specified tolerances or if the part is improperly started.

Each machine is based on a patented drive in which each spindle is driven by a hydraulic fluid motor. Depending upon the torque requirements, the motor may either be direct-connected to the torquing spindle, or a double-enveloping cone drive worm gear set may be incorporated in the drive. For driving a bolt, stud or nut, the hydraulic motor is run initially at low pressure and low speed. This provides a low torque drive and ensures positive engagement between the work and the rotating spindle sockets. The initial low torque prevents the driving of improperly fitted or cross-threaded fasteners. When the sockets have engaged the fasteners, an increased volume of oil is directed to the fluid motors. This causes the spindles to rotate at high speed and provides a fast run-down. When the fastener is within one or two turns of depth a valve is actuated by a depth-control finger to direct a high-pressure, low-volume oil flow to the hydraulic motor. Thus a high torque, slow speed drive is provided.

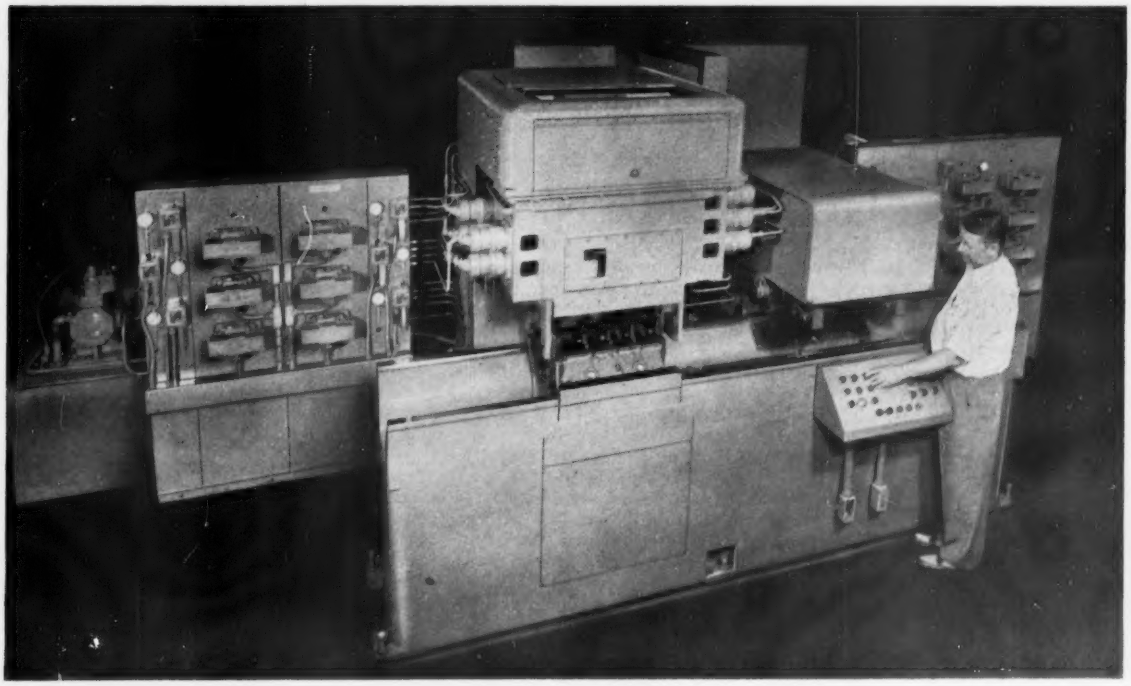
If the fastener is being tightened to a given torque, the hydraulic motor is stalled at the desired setting. The torque setting is adjustable to meet a wide variety of torque specifications. After the motor has operated for a fraction of a second at stall torque, the flow of oil to the motor is reversed under low pressure to free the spindle driving socket from the fastener. The work is then retracted from the spindles and ejected from the machine. If the fastener is being driven to a given depth or being tightened to a specified elongation, gauging devices shut off the fluid motor at the appropriate point.

Hautau nut torquing machines are available with capacities from 35 to 120,000 inch-pounds. Torque specifications can be held within a 2 per cent tolerance, and length or elongation within 0·0004 in. The machines are specially suitable for transfer type mass production assembly lines.

A typical machine

A recent Hautau development is shown in the accompanying illustration. This machine tightens 10 main bearing cap screws on a V-8 engine block. It works in conjunction with an in-line conveyor and has an auxiliary head that presses in ten ¼ in dowel pins in the bearing caps before the nut-torquing operation is carried out.

An operator mounts the caps on the engine block, starts the cap screws one or two turns and drops the dowel pins into slip fit holes in the caps. He then manually slides the block on the machine rails over transfer dogs and presses the cycle start button. The



Hautau automatic in-line transfer machine for pressing-in 10 bearing cap dowels and tightening 10 bearing cap screws on a V-8 block in 24 seconds

block is then automatically transferred to the pressing station where it is located by two retractable dowels in the pressing head. Individually controlled hydraulic cylinders then press all 10 dowels in to depth. A slow feed cylinder for one of the dowels, in addition to an interlocking system, ensures that all the dowels are pressed home before the block can be transferred to the next station.

From the pressing head the block is transferred to an idle station. It is next automatically transferred to the torquing station where it is hydraulically lifted to engage the 10 rotating torquing spindles. Cam surface on the vertical guides of the torquing head position the block for this operation. When all the screws have been tightened to the specified torque setting, the block is lowered and automatically transferred from the machine to the in-line conveyor. The cap screws are tightened to a torque of 1,080 in-lb. The cycle time for passage through the machine is 24 seconds.

This machine is 20 ft long, 11 ft deep and 8 ft high overall. Its JIC standard hydraulic control system includes sub-plate mounted valves on accessible panels at each end of the machine. The electrical control panel and two hydraulic motor, pump and tank units are at the rear. Each of the two hydraulic power units has three 220 V, 1,200 r.p.m., 10 h.p. motors connected to 30 g.p.m., 1,000 lb/in^2 pumps. Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11, are the sole agents for Hautau machines.

EXHAUST VALVE PROTECTION

The B.A.C. Brightray coating

IN the early days of the war it was realized that greater outputs from aircraft engines were an urgent necessity. It was also realized that greater specific outputs and improved thermal efficiencies could not be obtained without increased octane rating of the fuel, which involved increased tetra-ethyl lead contents. Unfortunately, further increase in lead content, at the valve temperatures current at the time, caused severe corrosion on the valve steel then used. The excellent resistance to corrosion by the products of combustion of leaded fuels offered by the 80/20 nickel-chromium alloys had been established and urgent development work was undertaken to produce this alloy in the form of a valve-coating alloy. A coating alloy designated B.A.C. Brightray was developed. During the war most aircraft engine valves were surfaced with Brightray and it was also widely used for the reclamation of exhaust valves for heavy vehicles.

Since the war the use of Brightray-coated valves has been extended. They are used by The Rover Company Ltd. and they are being used increasingly in diesel engines, especially those running on heavy fuels. Brightray can be applied either as a protective coating to valves during manufacture, or it may be used for reclaiming burnt-out valves. As applied to valves for road vehicles, the process is carried out in three stages:—

(1) The preparation of the valve head for the coating operation.
(2) The deposition by welding of the deposit.
(3) The machining and grinding of the coated head.

The process involves the deposition of a coating of an 80/20 nickel-chromium alloy, in the form of welding wire, applied by oxy-acetylene welding to the seat, rim and edge of the crown of the valve after the workpiece has been suitably prepared. This coating has a very high resistance to the corrosive attack of the products of combustion of leaded petrol and will withstand severe overheating in the engine without burning. Several advantages are claimed for the process. They include:—

(1) Ease of deposition. Flux is not required, and providing the flame setting is maintained a reasonably experienced welder can quickly obtain satisfactory deposits.
(2) Good machinability. The deposit can be machined to close limits on an ordinary lathe. Grinding is necessary only for finishing the seat face.
(3) Resistance to corrosion. Reports indicate that greatly extended life is obtained with Brightray-coated valves. They also have remarkable resistance to distortion at normal valve temperatures, and even at the high temperatures that may be reached locally owing to "blow-by" due to bad fitting, the resistance to cutting by the passage of high-speed gases is of an extremely high order.
(4) Cost. The cost of a Brightray-coated valve is little more than that of uncoated valves in the same steel.

CORRESPONDENCE

MOTOR VEHICLE LUBRICATION

SIR,—You are to be congratulated for drawing attention to the subject of lubrication, which is vital to the efficiency of motor vehicles and which has been so neglected by most manufacturers, to the detriment of users.

Efforts to eliminate as many lubrication points as possible in a motor vehicle have been made many years ago; and it does not seem to me impossible to satisfy the requirements of all lubrication points with no more than two or at the most three different lubricants.

Any bearing requires for preference a constantly renewed lubricating film, and in my experience this result is best obtained by using oil. Thus grease is eliminated. Only two types of oil need be considered at present to conform with temperature and bearing requirements; these are, engine oil, and high pressure lubricant which cannot yet be used in engines.

In 1918 I produced an experimental Talbot car type A12, which had already a simplified lubrication system. In this first attempt I abolished the open steering ball joint, which had been a curse up to then, and which, in spite of its leather gaiter, could not hold any lubricant for long and rapidly became dangerous if neglected. I replaced this joint by a closed one sealed by a spherical joint that was fed with oil contained in the connecting steering tubes used as reservoirs. I believe that this closed steering joint was the fore-runner of the modern one in general use to-day.

In Talbot cars, type 90, which I designed in 1929, and later the 95-105 and 110, every bearing in the vehicle was lubricated with oil coming from the engine crankcase, except the back axle, which was filled independently with thicker lubricant. The only point where grease was used, and then at very rare intervals, was the water pump gland greaser. With the modern carbon gland the use of grease would have been unnecessary.

Thus the owner of such a car could cover thousands of miles without any care other than filling his engine sump with oil or cleaning its filter when the dashboard warning instruments showed the need for it. What is still more to the point, he was not asked to pay a high price for the car and he also saved more on upkeep.

GEORGES ROESCH,
M.I.Mech.E., M.S.I.A., M.S.A.E.

53, Woodlands,
London, N.W.11.

PETROL INJECTION

The Recently Developed Bond System

FUEL injection has a number of advantages as compared with normal carburation. One of these is that it is possible to obtain with it a slightly higher volumetric efficiency, since the air does not have to be drawn through a carburettor throat and the combustion chamber can be more thoroughly scavenged. Another advantage is that distribution to the cylinders is generally better so that the full power output potentiality of the engine is more likely to be realized. For these reasons, many attempts have been made to develop simple injection pumps. The principal disadvantage of conventional injection equipment is that it is much more expensive than a carburettor. Moreover, because of the low viscosity of petrol, slight wear of the pump barrels and plungers would be likely to result in considerable leakage, which would be particularly serious at low speeds.

A new system is now undergoing development by Lawrence Bond, of Wormley, Surrey, the designer of the original Bond Minicar. In this system there is no mechanical drive from the engine, and the few precision ground components incorporated are simpler and do not have to be manufactured to such close limits as the plungers and barrels in conventional pump units. The layout illustrated is for a single cylinder engine with a barrel-type throttle, but schemes have also been prepared for multi-cylinder units and for use in conjunction with butterfly type throttles.

The basic feature of the system is a plunger, on one end of which is formed a piston. This plunger and piston unit is housed in a shouldered bore in the main casting of the unit, with the plunger end projecting into a chamber round the lower of the two trunnion-type pivots of the throttle valve. During the engine compression and power-strokes, the relatively high gas pressure is transferred through drillings from the cylinder head to the space between the piston and the plunger housing, and acts on the piston and withdraws the end of the injection plunger from the chamber round the throttle valve pivot. This action of the plunger draws fuel into the chamber. A cast iron piston-ring in a groove round the piston forms the gas seal.

When the pressure in the cylinder falls, a compression spring, bearing on the crown of the piston, returns the plunger and effects the injection stroke. The delivery passage is drilled in the lower pivot of the throttle, and the fuel is forced past a pintle valve, which lifts at 30 lb/in^2 and is carried co-axially in the pivot. The injected fuel is sprayed into the induction tract in the throttle barrel. Sealing round the upper end of the lower pivot is effected by means of a circular section rubber ring. A rich mixture for starting is obtained by opening the throttle, to obtain a long injection stroke, and then closing it quickly to restrict the air supply. Normally, the injection pressure is 300 lb/in^2, and the minimum operating gas-pressure is 100 lb/in^2 acting on the piston area of 0·147 in^2. The spring load on the piston is 14·7 lb.

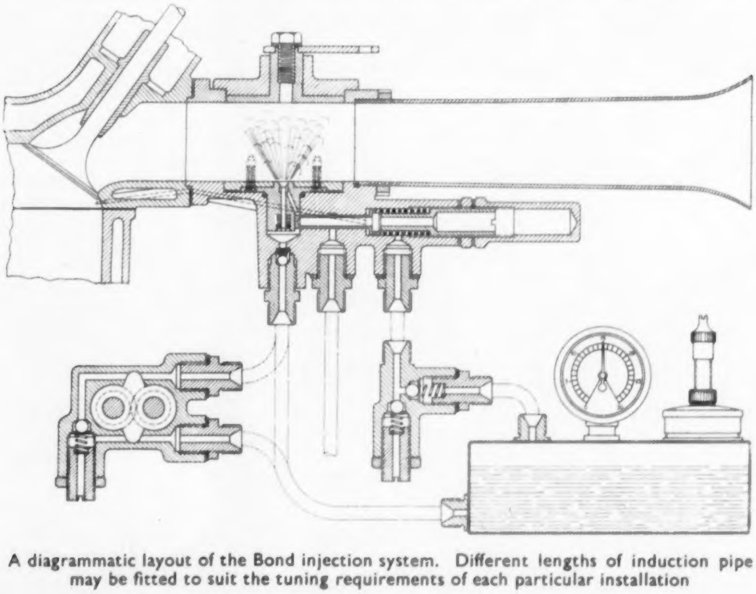
Although, in the illustration, the gas passage is shown drilled from the cylinder head, alternatively it may be taken from the cylinder wall. In either case, it is claimed that sludge and solid products of combustion do not block the entrance. The size of this entrance port has to be less than about 0·050 in, otherwise there is danger of combustion taking place in the passage and causing erratic operation.

There are two stops to limit the motion of the plunger; they are positioned one at each end. At the piston end, a screw type stop restricts the outward travel, and is used to adjust the mixture strength. The other stop is in the form of a cam profile on the pivot of the throttle valve. On completion of the injection stroke the plunger comes up against this cam, which is designed to control the length of the stroke to suit the throttle opening.

Lubrication of the plunger is effected by oil from the engine lubrication system, the pressure of which should not be less than 30 lb/in^2. The oil is taken through a union on the main casting of the injection unit to an annular groove mid-way between the ends of the plunger housing. This arrangement has been adopted to prevent fuel leakage along the plunger into the gas pressure chamber and to stop gas leakage, in the other direction, into the fuel chamber. Moreover, the oil film between the plunger and its housing tends to form an effective seal so that larger manufacturing tolerances between these two components can be allowed. It is claimed that the relatively high gas pressures prevent leakage of oil into the large diameter bore containing the piston and that a small seepage into the fuel chamber is immaterial.

When it is not possible to employ a gravity feed arrangement, the fuel supply is effected either by pressurizing the tank in a manner that will be described later, or by means of a gear type fuel pump, in the body of which is a relief valve, lifting at about 15 lb/in^2. Whichever arrangement is used, the fuel is passed through a union incorporating a ball-type, non-return valve, into the chamber round the throttle barrel pivot.

If the petrol tank is pressurized, a Schrader-valve connection is provided for pumping up the pressure with a hand pump before the engine is started. This is only necessary if the vehicle has been standing for a very long time and the pressure built up in the system during running has leaked away. When the engine is running, the pressure in the tank is maintained by gas leakage past the piston of the injector. In the illustration, a non-return valve and pressure relief valve are shown as being in a separate hous-



A diagrammatic layout of the Bond injection system. Different lengths of induction pipe may be fitted to suit the tuning requirements of each particular installation

ing in the pipe line to the tank, but this is only a diagrammatic sketch and these valves might well be housed in the main casting.

It is claimed that, because the fuel is injected into the induction tract, this system may be used to advantage in single cylinder engines. Improved performance is said to be obtained because the fuel is injected into the induction system about 120 deg before the inlet valve opens, and as a result, there is no tendency for fuel to become deposited in the inlet pipe, because the mixture becomes weaker as the induction stroke progresses. On the other hand, with the normal carburettor arrangement, the mixture entering the cylinder during the first part of the induction stroke is weak since, at this point in the cycle of operations, the air velocity through the choke is low.

Against this, it might be argued that in a high performance engine with a large amount of valve overlap, a weak mixture is desirable during the first part of the induction stroke, so that less fuel is wasted should any of the induction gases pass out of the exhaust port during the scavenging process. It would appear also that in the Bond system the injection rate will be constant regardless of engine running conditions. Therefore, as the throttle is opened and the quantity of fuel delivered increased, the injection period will also increase. This means that the rate of delivery would have to be such as to satisfy the requirements for high speed running, so at low speeds an unduly weak mixture might be delivered towards the end of each induction stroke. This effect might be to some extent countered by using a cylinder head giving a suitable degree of turbulence; however, turbulence tends to decrease as engine speed is reduced.

Doubtless, as is always the case with fuel injection, a considerable amount of development work would be necessary for each application of this system. Apart from the difficulties already mentioned, of satisfying the fundamental requirements of the engine, problems might arise in connection with the fouling of the gas passage from the combustion chamber. Moreover, in most systems difficulty is usually experienced in metering the very small quantities of fuel required. This problem tends to become more acute as the components become worn. Although the elimination of the need for a fuel pump by using a pressurized tank has its advantages, these might be more than offset by the amount of development work needed to perfect the pressurizing system. It would appear, therefore, that the arrangement in which a pump, although not necessarily a gear type unit, is incorporated might prove to be more acceptable.

Another difficulty that is common to all injection systems of this type is that of satisfying the requirements for operation at different altitudes. There are many parts of the world where motor vehicle operation at altitudes of about 2,000 ft is commonplace, and at this height an uncorrected injection system is as inefficient as a carburettor system at 4,000 ft. It need hardly be added that, to be acceptable for anything but special applications, an injection system must be at least as efficient as a carburettor and preferably less expensive.

BOOK REVIEWS

Recent German Publications

Automotive Engineering Handbook (Automobiltechnisches Handbuch)

Edited by Richard Bussien.

Berlin: TECHNISCHER VERLAG: HERBERT CRAM. $8\frac{1}{2} \times 6\frac{1}{2}$. Vol. I, 927 pp., Vol. II, 1,185 pp., together over 2,400 illustrations. Price DM 108 (1 DM = 1s. 8d.).

This work, the 17th edition within almost 50 years, is published for the first time in two volumes. It is not a revision of the earlier editions, but is a completely new and much enlarged work. The editor, whose father originated this handbook, does not need any introduction in German speaking countries, where "Bussien's Automobiltechnisches Handbuch" has long been regarded as a standard reference work.

Space has not been wasted in this work, for common mathematical tables normally to be found in handbooks have been omitted, but all the necessary tables and graphs dealing with specialized mathematical or theoretical subjects are included. Each contributor, whose subject involves any mathematical explanation, tabulates the formulæ for easy reference in the text matter. The field covered by this book justifies fully the large number of contributors. There is no definite division of subjects between the two volumes, although a number of chapters on pure theoretic subjects appear in the first volume, there are also chapters to be found on such diverging subjects are automatic transmissions, air-conditioning, heating and ventilating of vehicles, chain drives, chassis frames, engine design, etc. The second volume, divided into eighteen chapters, has some on exhaust and intake silencing, electrical equipment, trailer design, agricultural tractor, industrial vehicles, gas-turbines, commercial and municipal vehicles, etc., and even on motor-cycle design. As a suggestion for future issues the very detailed index of each volume may well be provided with a cross reference.

The Gas Engine (Die Gasmaschine)

By Dr.-Ing. Max Leiker.

Vienna: SPRINGER VERLAG. $10\frac{1}{4} \times 7\frac{1}{4}$. 260 pp., 358 illustrations. Price O.S.284 (£1 = 72 O.S.).

This book, now in its second and enlarged edition, is the fifth volume of a series of sixteen entitled Die Verbrennungskraftmaschine (The Internal Combustion Engine). The series was started in 1949 under the auspices of Prof. Dr. Hans List of Graz, and will eventually cover all technical aspects of internal combustion engines. It is a most comprehensive and up-to-date study, by an author who is associated with a well-known Continental engine manufacturer and who is regarded as a leading authority on this subject.

Initially, the fundamental principles underlying the subject of gas engines and the characteristics of gaseous fuels, including natural, refined and generator produced gases, are briefly dealt with. The author then deals very thoroughly with their respective combustion characteristics. Almost an entire chapter is devoted to the analysis of combustion irregularities and their causes. One of the most informative sections of the book is that dealing with exhaust turbo chargers, where the author relates some of his research experiences with the peculiarities of certain methods of installations and equipment employed. Mechanical constructional features of stationary gas engines are dealt with in several chapters, and in the chapter devoted to automotive application, both air- and water-cooled engines are considered.

Bosch Automotive Pocketbook (Bosch kraftfahrtechnisches Taschenbuch)

Dusseldorf: DEUTSCHER INGENIEUR-VERLAG G.M.B.H. $5\frac{3}{4} \times 4\frac{1}{4}$. 416 pp., over 300 illustrations. Price DM 8 (1 DM = 1s. 8d.).

The eleventh edition of this pocket book printed on bible paper has been completely revised and enlarged. The first issue of this work, a private publication issued almost 20 years ago by Robert Bosch G.m.b.H., contained various mathematical tables and a description of Bosch electrical products. Since those days the production of the work has been entrusted to the present publishers, and although senior technical executives of Bosch are responsible for the periodic revision of this book, there is no reference made to Bosch products. In German-speaking countries, this compact little volume has long been established as a standard source of reference.

Divided into twelve major chapters, this work in no way abbreviates any information which is normally frequently required by designers and engineers. The first chapter, devoted to mathematical formulæ, measures and weights, contains also most comprehensive conversion tables of metric, American and British measurements and all such combinations which are applicable in automobile engineering. Other chapters dealing with physics, chemistry, strength of material, fuels and lubricants, engine and vehicle design, mechanical and electrical components, contain tables and data which are very carefully selected for their informative value.

THE CUMMINS DIESEL ENGINES

A Series of High-Output, Four-Stroke Engines for Commercial Vehicles

A SUBSTANTIAL majority of the diesel-engined lorries in use in the United States are fitted with engines made by the Cummins Engine Company, Inc., of Columbus, Indiana. Exact figures have never been announced, but it is safe to state that upwards of 50,000 Cummins diesel engines are in service on the road. This Company was incorporated in 1919 and first made stationary oil engines under Hvid licence. These engines proved unsatisfactory and, in 1922, a change was made to the manufacture of marine engines of Cummins design. In 1930 — at a time when the first oil-engined vehicles in Great Britain had been in service only two years — Mr. C. L. Cummins made a determined effort to introduce his engines into automotive service in America. They were demonstrated in an automobile, a lorry and a bus. He even entered a racing automobile fitted with one of his oil engines in the Indianapolis Speedway race, where it completed the full 500-mile course non-stop, at a speed of about 85 m.p.h.

To-day, the Cummins Engine Company produces a range of automotive engines rated at from 100 b.h.p. to 300 b.h.p., maximum output. These engines have an established reputation in lorry and bus service and, with modifications, are widely used in well-drilling, earth-moving and strip-mining equipment and in stationary and marine service.

General design

The complete series of Cummins engines for automotive service is shown in the table. Those engines for which " S " appears in the model designation are supercharged and it will be noted that almost every model is offered either with or without a supercharger. All these engines are six-cylinder units, with the exception of model HRB-400, which has four cylinders. With the exception of models NHHB-600 and NHHBS-600, which are intended for horizontal installation in underfloor-engined buses, all are designed for vertical installation. The Company also manufactures a series of twelve-cylinder engines and a number of six-cylinder units of 7 in × 10 in and 7¼ in × 10 in bore and stroke, but these are intended for industrial and marine service.

Apart from their unique injection system, Cummins diesel engines are conventional in design. All are of the four-stroke, direct-injection type. They are exceptionally robust and have deep cast-iron crankcases.

CUMMINS ENGINES, AUTOMOTIVE RANGE

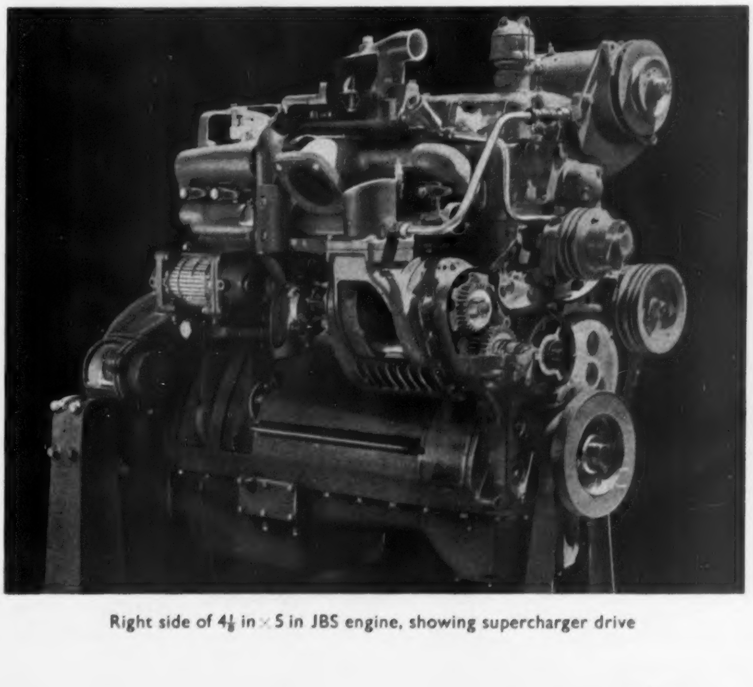
HRB-400 is 4-cylinder engine, all others are 6-cylinder units. "S" models are supercharged

Model	Bore and Stroke in	Swept Volume		Rated Output b.h.p. at r.p.m.	Weight lb
		in³	litres		
AA-600	4 × 5	377	6·2	100—2,200	1,440
JBS-600	4⅛ × 5	401	6·6	150—2,500	1,545
HB-600	4⅞ × 6	672	11·0	150—1,800	2,395
HBS-600	4⅞ × 6	672	11·0	200—1,800	2,580
HRB-400	5⅛ × 6	495	8·1	110—1,800	1,640
HRB-600	5⅛ × 6	743	12·2	165—1,800	2,400
HRBB-600	5⅛ × 6	743	12·2	175—2,000	2,450
HRBS-600	5⅛ × 6	743	12·2	225—1,800	2,580
NHB-600	5⅛ × 6	743	12·2	200—2,100	2,480
NHHB-600	5⅛ × 6	743	12·2	200—2,100	2,330
NHBS-600	5⅛ × 6	743	12·2	275—2,100	2,775
NHHBS-600	5⅛ × 6	743	12·2	275—2,100	2,575
NHRBS-600	5⅛ × 6	743	12·2	300—2,100	2,725

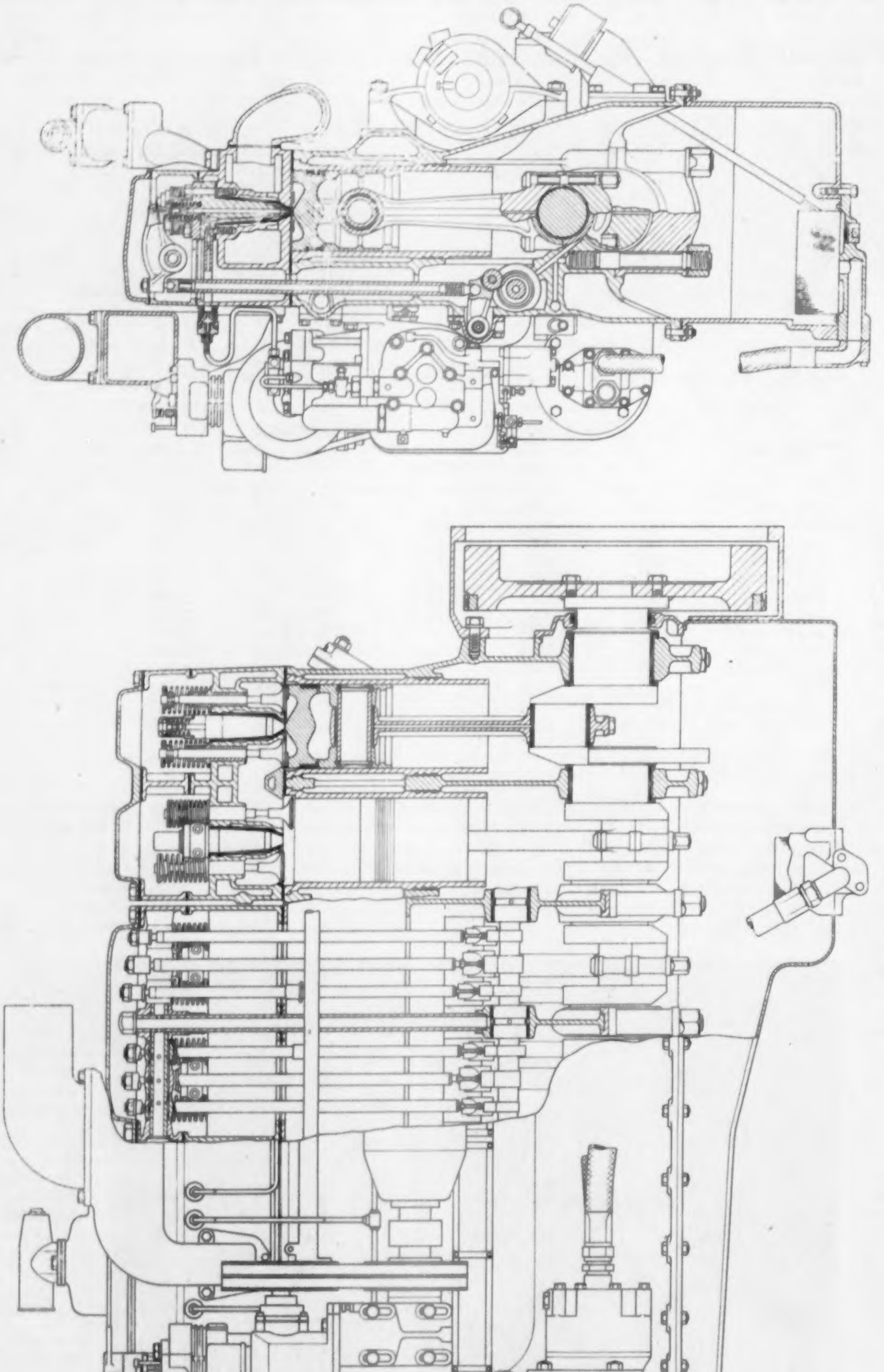
Fuel injection system

A fuel injection system of Cummins own design and manufacture is incorporated. It consists essentially of a gear-type feed pump, which draws fuel from the tank and supplies it to a single-plunger metering pump. This metering pump supplies measured charges of fuel, at a pressure of about 150 lb/in², through a disc-type distributing valve to each injector in turn.

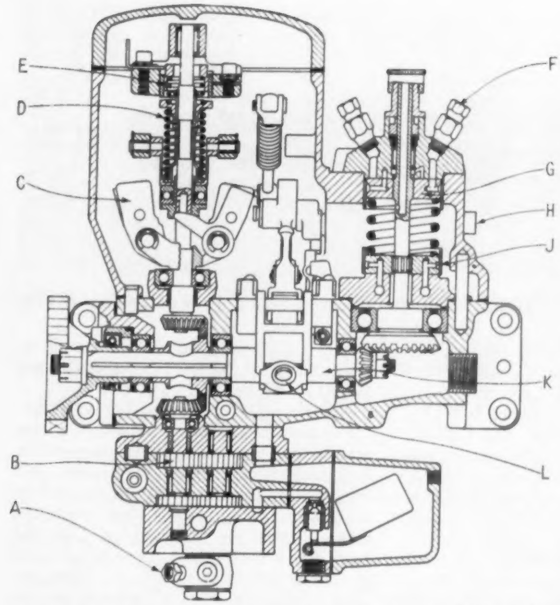
These injectors are mounted on the cylinder heads, and they each receive their charge of fuel during the appropriate compression stroke of the engine. As the piston rises on the compression stroke, a small quantity of air is forced up through the open nozzle and mixed with the fuel. It is claimed that this mixing of fuel and air, together with the pre-heating that takes place in the injector, prepares the fuel for rapid ignition. Towards the end of the compression stroke, the injector plunger is driven downward by a push rod and rocker, actuated from the engine camshaft, and the fuel-air mixture is forced into the combustion chamber. The timing and rate of injection have been worked out so as to obtain the best



Right side of 4⅛ in × 5 in JBS engine, showing supercharger drive



GENERAL ARRANGEMENT OF CUMMINS NHB ENGINE
Bore $5\frac{1}{8}$ in. Stroke 6 in. Swept volume 743 in^3 (12·2 litre)



A, Fuel inlet: B, Gear pump: C, Governor: D, Max. speed spring: E, Idling spring: F, Fuel outlets: G, Discharge disc: H, Manual control: J, Suction disc: K, Camshaft: L, Cam rocker lever

Fuel metering and distributing pump

performance. In order to ensure that no fuel can remain behind in the injector, to form gum or carbon, the injector plunger is adjusted to bottom in the injector nozzle cap. The timing of the injection is fixed, that is, it does not vary with engine speed. An idling and speed-limiting governor is installed in the metering pump and distributor housing.

Certain advantages are obtained with the Cummins injection system. All metering is done by a single plunger, so there is no possibility that the fuel charges may be unequal, either because of faulty adjustment or wear. The fuel pipe lines are not subjected to high pressures and, therefore, are less likely to leak. Injection is directly under the control of a mechanically operated plunger, which could hardly be closer to the nozzle, so there is no question of pipe-line surging or delivery-valve flutter varying the charge as in conventional systems. Moreover, it seems to require less attention during service. On the other hand, the Cummins injection system is somewhat heavier and more complex than more orthodox systems and probably costs slightly more to manufacture.

The minimum full-load fuel consumption of the Cummins automotive engines varies from 0·39 to 0·42 lb/b.h.p.-hr for the unsupercharged models. By British standards, these figures may seem high for a direct-injection engine, but they are readily accepted in the U.S.A.

Crankcase and crankshaft

In all these engines, the alloy cast iron crankcase and cylinder block unit is extended well below the crankshaft centre to form an exceptionally rigid structure. Wet cylinder liners are employed and they are sealed by means of the usual flange at the top and rubber sealing rings at the lower end. The crankshaft is carried in seven steel - backed, copper-lead main bearings (five in the case of the four - cylinder engine) and the bearing caps are each secured by two bolts and located transversely between machined shoulders.

A forged alloy steel crankshaft, Tocco - hardened on all crankpins and main journals, is fitted. The crankpins are $2\frac{5}{8}$ in diameter in the two engines with 4 in and $4\frac{1}{8}$ in bores and $3\frac{1}{8}$ in diameter in all the larger engines listed in the Table. In the two smaller engines, the main journals are $3\frac{7}{8}$ in diameter and in the larger engines they are $4\frac{1}{2}$ in diameter. This last figure gives a main journal-to-bore ratio of 0·88 to 0·92. These are certainly high figures and are an indication of the exceptional rigidity of the crankshafts. All the crankshafts are balanced by means of counterweights forged integrally with the webs.

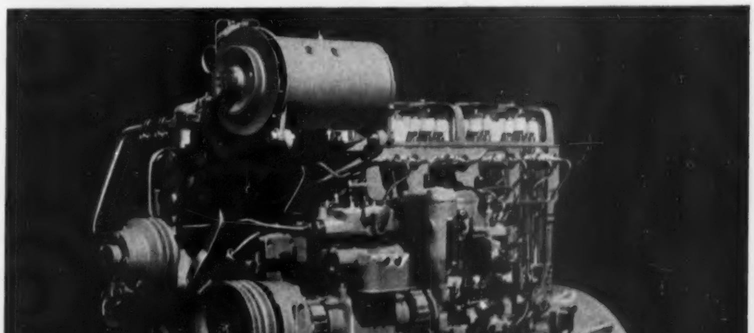
Houde viscous-fluid dampers are fitted at the front end of the crankshafts. These dampers consist of a sheet-steel housing in which is a cast iron ring, or flywheel. The flywheel is a snug fitting in the housing, but is free to rotate independently. During manufacture the small space between the housing and flywheel is completely filled with a silicone fluid and the unit is then permanently sealed. This type of damper has been found to perform very well and can be expected to operate consistently throughout the life of the engine.

The connecting rods, conventional in form, are alloy steel forgings, heat-treated and drilled along their axes to carry oil from the big-end bearing to the gudgeon pin. Two bolts secure each big-end bearing cap and steel-backed, copper-lead lined bearings are fitted. The connecting rods for the two 5 in-stroke engines have a centre-to-centre length of $9\frac{1}{2}$ in and, complete with cap, bolts, small-end bushing and big-end bearing, weigh 6 lb each. In the engines with a 6 in stroke, the connecting rods are 12 in long and weigh $10\frac{1}{2}$ lb each complete.

Cast iron pistons are employed in the 4 in and $4\frac{7}{8}$ in bore engines and the 4-cylinder unit, while aluminium pistons are used in the $4\frac{1}{8}$ in bore and the remaining $5\frac{1}{8}$ in bore engines. All have three compression rings and either one or two oil-control rings. The pistons are cam and taper ground and the aluminium pistons are knurled on the rubbing surfaces to prevent any danger of scuffing. The 4 in and $4\frac{1}{8}$ in pistons are fitted with $1\frac{1}{2}$ in diameter gudgeon pins, while the larger pistons have 2 in pins. All gudgeon pins are free in both the piston and connecting rod.

Cylinder head and valves

The cylinder heads are of cast iron and, in all models except two, they are



Fuel metering pump and water pump are mounted on left side of the JBS engine

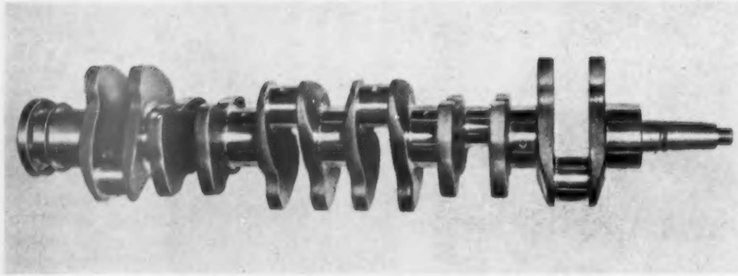
cast in pairs; the exceptions are the AA-600 and JBS-600 units, each of which has a monoblock head. Most of the working load of any one cylinder is carried on four studs, placed close to and uniformly spaced about that particular cylinder. Additional studs are, of course, provided in order to ensure local pressure about water and push-rod openings.

All valves are mounted vertically in the cylinder head. In the majority of these engines, a single inlet valve and a single exhaust valve is provided for each cylinder. However, in engines rated at 200 b.h.p. or more (except the HBS-600 and the HRBS-600), four valves, two inlet and two exhaust, are used in each cylinder. It may be noted that all the four-valve engines are rated to deliver their maximum output at 2,100 r.p.m. while, perhaps a little inconsistently, one two-valve engine is rated at 2,200 r.p.m. and another at 2,500 r.p.m.

As in all direct-injection engines with centrally positioned injectors, valve size is strictly limited. This is especially true with the Cummins injector, which is relatively large in diameter. Nevertheless, it has been possible to provide $1\frac{11}{16}$ in outside diameter valves in the two-valve $4\frac{7}{8}$ in and $5\frac{1}{8}$ in cylinders and $1\frac{3}{4}$ in outside diameter valves in the four-valve, $5\frac{1}{8}$ in diameter cylinders. The smaller cylinders of 4 in and $4\frac{1}{8}$ in diameter have, of course, somewhat smaller valves. Both the $1\frac{11}{16}$ in and the $1\frac{3}{4}$ in valves have a lift of 0·5 in. In all instances, the inlet and exhaust valves are of identical size. The exhaust valve seats are of steel, Stellite-faced and shrunk into position.

The valve gear is straightforward, except that the tappet for the injector push-rod is a lever, one end of which is pivoted in a cover attached to the side of the crankcase, the other carrying a roller that follows the profile of the injector cam. In the case of the four-valve engines, the usual problems arise with regard to the operation of four valves from two push-rods on the same side of the engine. In these engines, the valve rockers and their shafts are mounted in a separate casting, which is sandwiched between the cylinder head and the valve cover.

On the camshafts, the cam surfaces and the journals are carburized and case-hardened. The steel timing gears



Fully counterweighted crankshafts with seven journals are used in all six-cylinder engines

are heat-treated and have helical teeth. Valve timing for a typical engine, without a supercharger, is as follows:

Inlet opens	20 deg B.T.D.C.
Inlet closes	50 deg A.B.D.C.
Exhaust opens	55 deg B.B.D.C.
Exhaust closes	25 deg A.T.D.C.
Injection starts	50 deg B.T.D.C.
Injection ends	20 deg A.T.D.C.

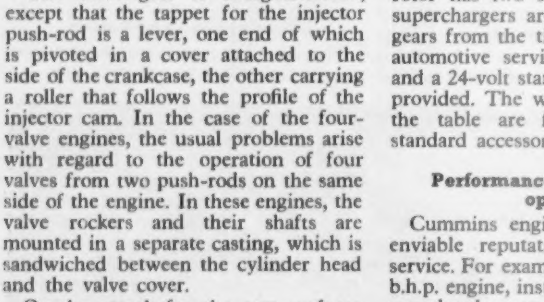
Auxiliary equipment

The fuel pump and governor unit is driven by the timing gears from the front end of the crankshaft. A gear-type lubricating oil pump is also driven from the timing gear train. The air compressor, required for vehicles fitted with compressed-air braking systems, is driven by means of twin belts in all the newer models, while the water pump and fan unit has a separate twin-belt drive from an auxiliary shaft.

In the pressure-charged models, the supercharger, manufactured to Cummins specifications by the Schwitzer-Cummins Corporation, of Indianapolis, Indiana, is of the Roots type and each rotor has two straight lobes. All the superchargers are driven by means of gears from the timing gear train. For automotive service, a 12-volt dynamo and a 24-volt starting motor are usually provided. The weight figures given in the table are for engines with all standard accessories fitted.

Performance in commercial operation

Cummins engines have achieved an enviable reputation for durability in service. For example, one particular 200 b.h.p. engine, installed in a tanker lorry, completed a run of 300,000 miles without a major overhaul. It is true that, during this period, injectors were changed and several cylinder heads had to be replaced — a fairly common failure in America because of severe operating conditions—but no work of any sort was done on the pistons or bearings.



Connecting rods have bulb webs drilled for the positive lubrication of the small-end bushes

It is interesting to note that the daily run of this lorry was 770 miles, which was covered at an average speed, while on the road, of $37\frac{1}{2}$ miles per hour. Fuel consumption averaged 152 British ton-miles per Imperial gallon.

An average fuel consumption figure for Cummins engines installed in trucks weighing about 31 British tons when fully laden is about 6·6 miles per Imperial gallon. In making comparison with British figures for fuel consumption, it must be remembered that the trucks in which these engines are used generally cruise at about 50 miles per hour. The 300 b.h.p. Cummins engine is widely used in logging operations, where the vehicle is operated mainly on private roads and its gross weight together with the load frequently reaches 125 tons.

In the strip mining of coal and iron ore, a 275 b.h.p. Cummins engine recently established a record by hauling 310 ton-miles of payload per hour. The gross weight of the vehicle and payload was $63\frac{1}{2}$ tons. In vehicles as large as this, it is now more usual to install two of the largest Cummins engines side-by-side; each engine drives a separate rear axle.

For coach service, the 200 b.h.p. horizontal engine installed in a 37-passenger coach averages 9·8 miles per Imperial gallon. The cruising speed is 60 m.p.h.

Racing engines

It will be of interest to add a brief description of the Cummins diesel engines that were prepared for the Indianapolis Speedway 500-mile races in 1950 and 1952. In both years, the JBS-600 engine, with six cylinders, $4\frac{1}{8}$ in × 5 in, was used. As a lorry engine, this model is rated at 150 b.h.p. at 2,500 r.p.m.

The 1950 engine was fitted with a four-valve cylinder head, and a supercharger designed for one of the 743 in^3 engines, directly driven from the front of the crankshaft. With small changes to the compression ratio, the injector, and to the piston and bearing clearances, this engine finally gave an output of 340 b.h.p. at 4,000 r.p.m. By substituting, wherever possible, aluminium or magnesium for cast iron, the weight of this engine was reduced to 840 lb dry, or 2·47 lb/b.h.p. The 1950 car ran very well in the race—due to the low rate of fuel consumption refuelling stops were unnecessary—until forced to retire by a broken crankshaft-damper*.

In developing this engine further for

*Miller, J. C. and Boll, C. R., 'Journal of the Society of Automotive Engineers', October 1950, p. 52.

the 1952 race, the principal change was to fit an exhaust turbo-charger. By this means, the maximum power output was increased to over 350 b.h.p. at 4,000 r.p.m. or 0·87 b.h.p/in^3 displacement. At the same time, the engine was arranged to be installed horizontally, with the drive shaft passing to the left of the driver. This layout shifted the centre of gravity toward the inside of the turns and also made it possible to lower the air resistance of the car by keeping the height of the engine cowling to within 29 in from the ground.

With these changes, the 1952 car set a new "qualifying" speed record (a flying 10 miles, or four times round the track) of 138 m.p.h. In the race, the car had to retire after seventy-two laps, on account of an accumulation of rubber and dirt drawn into the supercharger from the track. The danger of this had been foreseen, but space was not available in which an adequate air cleaner could be accommodated.

The development of these racing engines has undoubtedly brought improvements to Cummins commercial engines. It has also shown that oil engines can approach the high specific outputs now attained by racing-type petrol engines, that satisfactory combustion can be obtained at comparatively high engine speeds and that the exhaust turbo-charger should have definite advantages for commercial-vehicle engines, providing means can be found to reduce its high initial cost.

CHEVROLET CORVETTE

A Plastics Bodied Sports Car Produced in Relatively Large Quantities

SOME details of the manufacture of the plastics body of the Chevrolet Corvette, the first to be produced in large numbers in the United States, are given in a well-illustrated article in the December 1953 issue of *Modern Plastics*. In this article, it is said that the Chevrolet design and production engineers estimate that 15,000 cars is the numerical limit beyond which, from a cost point of view, it is more economical to make the bodies of sheet steel instead of reinforced plastics. However, this estimate may be changed if improved manufacturing techniques are developed. Moreover, the advantages of a plastics body should also be taken into account. These include light weight, ease of repair, corrosion resistance and possibly a longer service life.

Unlike most plastics bodies, which are usually made in either one or two parts, the Corvette is made in forty-one pieces of which about seventeen are listed as major components. Assembled, it weighs approximately 410 lb, whereas a similar body made of steel would weigh about 600 lb. At present, a number of different moulding processes are being used experimentally to discover which is the most suitable. However, by the time the output has been increased from the current rate of three per day to thirty per day, a figure that is hoped to be reached early this year, it is expected that all the moulding will be done with matched metal dies. This method is at present being used in the production of the instrument panel, because it gives a superior finish.

The manufacturers state that the total tooling costs for the Corvette body will be approximately 500,000 dollars, whereas for a similar sheet steel body they would be 4,500,000 dollars. In addition to this saving in cost, another advantage obtained was that it was possible to put the new car into production in only a fraction of the time required for a more conventional metal body. Much of this time saving was made possible by the use of cast phenolic dies for the manufacture of some components and epoxy-fibrous glass moulds for others.

So far as manufacture is concerned, the low weight of the material promotes ease of handling, and the body sections are not readily damaged during transport and assembly. One man can lift a major body section and two can carry a complete body shell. Heavy stamping processes are not required for forming plastics panels, and the speed and ease with which components can be moulded experimentally is an asset to the body designer.

To facilitate production, the panels are divided in such a way as to form a horizontal joint along each side of the body. This joint is concealed by a chromium plated moulding. Various polyester resins are used, since no single material is suitable for all applications. For instance, chlorinated resins are employed in areas where heat resistance is important. In general, the finished body is approximately 50 per cent polyester resin and 40 per cent fibrous glass mat or cloth. The difficulties that had to be overcome were not as great as at first expected. Differential rates of thermal expansion between the plastics panels and the metal frame presented no problem even though the body is almost 14 ft long. Likewise, water absorption is negligible and has no ill effect on the painted finish of the car.

The floor, toe board, sills, rear seat pan, boot floor and rear wheel arches are in one piece, which measures 6 ft by 9 ft 6 in and weighs 75 lb. This is the largest plastics component in the body and provides the foundation to which the other components are attached by means of polyester cement and rivets. It is moulded, by the hand laying-up process, in eight different parts, in epoxy-fibrous glass moulds backed up with plaster. The fabrication process takes approximately 4 hours, but it is hoped eventually to reduce this to 20 minutes. Metal inserts are moulded into the panels at the points where they are attached to the chassis frame. Other components, including the front and rear ends, rear seat squab, instrument panel, boot and bonnet lids and door panels are at present being made by the rubber bag method.

The surface of the mould is first sprayed with a parting agent and then Gellcoat, which dries to milky whiteness and leaves a smooth exterior surface on the finished part. Next, three layers of fibrous glass mat are laid up, the first two being coated with resin. A back-up mould is then placed in position over the lay-up, and pressure exerted by clamping a polyvinyl sheet over the assembly and exhausting the air from between the sheet and the mould. Heat, augmenting the exothermic heat produced by the resin itself, is applied to cure the resin. After removing the finished sections from the mould, the edge flash is bandsawed, and the edges are finished with an abrasive wheel.

For some of the smaller, and more intricate parts, cast phenolic moulds are employed. For instance, a three-piece, box mould is used for the tail pipe ducts. The layers of fibrous glass matt and resin are placed round a removable core inside the mould base, which is capped with a mould ram that forms the top section of the die.

At present, in the assembly plant at Flint, the body assembly line is in the centre of the building, and it is flanked on one side by the chassis line and on the other by the paint booths. In the body assembly area are the jigs and fixtures on which the panels are joined to form two main sections. The major assemblies are then bonded together with polyester cement and riveted. Spring loaded clamps are used to hold the body sections together while the cement is setting. The use of these clamps makes it possible to drill and rivet the flanges before the curing of the joint is complete. After the adhesive has cured, the joints are ground down and sanded, so that they become almost invisible even before painting. Small steel backing plates are employed to relieve stress concentrations round points where plastics-to-steel joints are made.

The paint process is similar to that used for more conventional bodies. The paint bonds well to the fibrous glass laminate and completely masks the fibres. It may be polished with the same type of waxes and other preparations used for steel bodies. After the prime and finishing coats have been sprayed on, and dried by infra red lamps, the shell is trimmed and wired ready for assembly to the chassis.

THREAD ROLLING

Equipment for Use on Capstan, Turret Lathes and Drilling Machines

FOR many applications, thread rolling is the most effective method of producing screw threads cheaply and accurately. Production costs for rolled threads will frequently be lower than those for cut threads. In addition, the surface finish of a rolled thread is usually better than that of a cut thread, and on suitable materials it will have a better grain flow and increased fatigue resistance. Pitch form and accuracy can be held to very close tolerances.

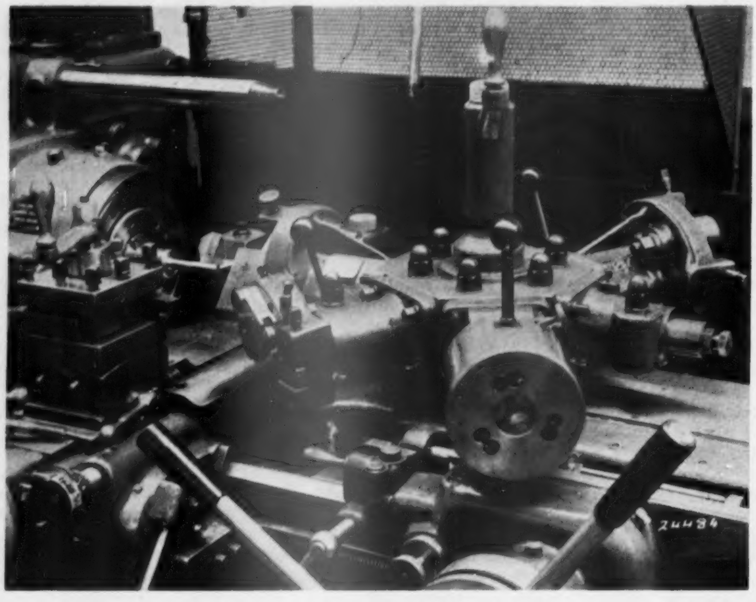


Fig. 1. Tooling layout, including a Rollrite diehead, for machining a pad bolt on a Herbert capstan lathe

To allow the thread rolling process to be employed without necessitating the installation of a thread rolling machine, Alfred Herbert Ltd., Edgwick, Coventry, have recently developed the Rollrite thread rolling diehead for use on capstan and turret lathes, drilling machines and automatic machines of all kinds. The first of these dieheads is for use on manually-operated machines and will cut threads of all commercial pitches from $\frac{1}{8}$ in to $\frac{3}{4}$ in diameter. In due course a full range of sizes and types will be marketed. A tooling layout, including a Rollrite diehead, is shown in Fig. 1 and a diehead in Fig. 2.

The Rollrite diehead is of the self-opening type with the annular thread rolls carried in swinging carriers positioned and adjusted for size by a cam-shaped housing similar to that used in the Coventry diehead. The carriers present the rolls at the correct helix angle to the work. After the initial engagement they are self-feeding and automatically control the pitch and form of the thread. Adjustment for size is made by a screw similar to that on the Coventry diehead. At the point of tripping, a self-opening mechanism opens the rolls simultaneously by pulling off the carrier supporting body from the driving dogs on the shank. When the driving dogs are disengaged, the spring-loaded carriers fly open clear of the work.

Within the range of the diehead, one set of roll carriers suits all commercial pitches of the same hand, and each set of rolls for a given pitch will roll threads of any diameter of work and of either hand. To change the rolls the diehead front plate is removed to allow the carriers to be lifted out. The rolls run on pins secured in the carriers and can be taken out and changed in a few minutes.

The leading threads of the rolls are specially shaped to facilitate the rolling action, and since the leading threads on each of a set of rolls are arranged to act in sequence, the rolls are mounted in the carriers in a special order. They are clearly numbered for correct assembly. To obtain a double life from each roll, they may be reversed in the carriers. The shaping of the leading threads on each roll leaves an imperfectly formed final thread on the component. This incompletely formed thread extends for little more than a full pitch, which is less than the run-out obtained with conventional dies.

Fig. 2. The new Herbert Rollrite thread rolling diehead

Since the rolling action depends upon the flow of the work material, it follows that more power is required for thread rolling than for thread cutting. As an approximate guide, thread rolling calls for about 50 per cent more power than would be required to cut a similar thread with a diehead. This does not present any practical difficulties, since most machines have ample power available at the speeds used for thread rolling. An important operating point is that at the start of the rolling operation the thread rolling diehead must be forced on to the work with much more effort than would be used for a cutting diehead.

Thread rolling can be carried out at higher speeds than are used for thread cutting. In fact development work carried out by Alfred Herbert Ltd. suggests that in the near future it will be possible to roll threads at the same speed as that at which the component is turned. If this can be accomplished, it will prove of convenience for applications on bar automatics, since it will obviate the need for speed changes between the turning and threading operations. Speeds at present recommended for rolling threads on steel range from 500 r.p.m. for $\frac{1}{8}$ in diameter work to 250 r.p.m. for $\frac{3}{4}$ in diameter.

Thread rolling must never be attempted without lubrication. The diameter of the component to be thread rolled must be accurately controlled. It is usual to turn the blank to the screw effective size to a tolerance of 0·001 in all plus. The size varies with different materials but in setting care must be taken not to overfill the die roll form.

LIQUID COOLING

The Development of Coolant Systems for the Engines of Heavy Commercial Vehicles

J. L. Koffman, Dipl. Ing., M.I.Loco.E.

In the design of buses, coaches and heavy commercial vehicles, the current tendency to locate an engine of higher power output under the floor makes it imperative to develop auxiliary equipment for increased effectiveness. So far as the cooling system is concerned, this means that greater quantities of heat must be dissipated without increasing component sizes. In addition, because of the limited space available, the radiators should be made more effective than before. This will reduce not only the space requirements, and with it weight and cost, but the fan power as well.

Here immediate improvement is offered by pressurizing the cooling system. It will be recalled that according to Newton's (1701) law of heat transfer

$$Q = h \times A \times \Delta t \text{ [B.Th.U/min]}$$

where Q = heat dissipation [B.Th.U/min], h = overall heat transference [B.Th.U/min (ft^2) (deg F)], A = effective radiator area [ft^2] and Δt = temperature difference between hot and cold media [deg F]. Thus, everything else remaining the same, Q will be directly proportional to Δt. Since it is not possible to alter the temperature of the ambient air entering the radiator, the higher the coolant temperature, the greater is Q, or for Q = constant, the smaller is A. Apart from this, an increase of coolant temperature reduces the difference between cylinder and coolant temperature and with it the amount of heat absorbed by the coolant. Tests with diesel engines have shown that in the normal operating range, increasing the temperature by 10 deg F reduces Q by about 2·5 per cent, whilst the lowered volumetric efficiency reduces the power output by 0·1 to 0·3 per cent.

The advantages obtained by pressurizing are best illustrated by considering a diesel engine developing, say, 120 h.p. with $Q = 4070$ [B.Th.U/min], a temperature drop through the radiator of 16 deg F and the vehicle operating in an ambient air temperature of 100 deg F. Allowing for a safety margin of 10 deg F for performance deterioration, the mean temperature difference Δt will be: $\Delta t = 212 - (100 + 10 + 16/2) = 94$ deg F, for a normal cooling system, whilst when pressurized to 5, 10 and 15 lb/in^2 this value will increase to 110, 121·5 and 131·5 deg F respectively. With the frontal area of the radiator matrix limited to, say, 2·5 ft^2, the air velocity required when using a 10-tube row, 5 in deep, continuous gill and tube matrix, Fig. 1, and maintaining a coolant flow of 22 gal/(min) (ft width) will be 25, 20, 17·5 and 16 ft/sec. The static pressure loss due to matrix alone is 1·06 in W.G. at 25 ft/sec. Assuming a loss of 2·5 in W.G. for the complete system and a fan efficiency of 60 per cent, the power required by the fan will be 2·4, 1·31, 0·895 and 0·665 h.p. respectively. As will be noted from Fig. 1, Q is proportional to Δt, A and $V^{0{\cdot}742}$, whilst Δp is proportional to $V^{1{\cdot}84}$. Thus for a given value of Q the fan h.p. will be proportional to $A \times V \times \Delta p$ or $A \times V \times C \times V^{1{\cdot}84}$ (where C is a constant), that is $C \times A \times V^{2{\cdot}84}$. Q is proportional to (fan h.p)$^{2{\cdot}84/0{\cdot}742}$ = (fan h.p)$^{3{\cdot}82}$ or conversely fan h.p. is proportional to $(\Delta t_1/\Delta t_2)^{3{\cdot}82}$.

If the fan h.p. is constant Q will be proportional to Δt, whilst with both fan h.p. and Q kept constant, the matrix area will be proportional to $(\Delta t_1/\Delta t_2)^{1{\cdot}84/3{\cdot}82} = (\Delta t_1/\Delta t_2)^{0{\cdot}482}$. Consequently, in the case considered here, increasing the pressure from 0 to 5 lb/in^2 and thus raising the temperature difference from 94 deg F to 110 deg F, will permit a matrix area reduction to $(94/110)^{0{\cdot}482} = 0{\cdot}87$ of the original size, assuming that the rest of the system passages are reduced accordingly. Thus the cooling system will benefit considerably from pressurization, because of reduced bulk, weight and cost, reduced fan h.p., belt wear and fuel consumption, reduced fan noise, or a combination of these factors.

In view of the all-round benefits secured by pressurizing, it is surprising that relatively little use has been made of it in the commercial vehicle field. One objection usually made is that whilst the system will not boil at temperatures in excess of 212 deg F it will do so as soon as the filler cap is removed, and possibly scald the driver or mechanic. However, filler caps of pressurized systems are designed to release pressure before being fully open, thus providing sufficient warning. In addition, the loss of coolant due to evaporation is almost completely eliminated, thus making frequent inspection unnecessary. The reduced incidence of topping-up in turn reduces the furring-up of radiator tubes.

Another objection is that higher pressures might be more conducive to leakage at cylinder block joints, pump glands and rubber hose connections. Some difficulties have been encountered with engines of the light marine variety designed for indirect sea water cooling. It must be mentioned, how-

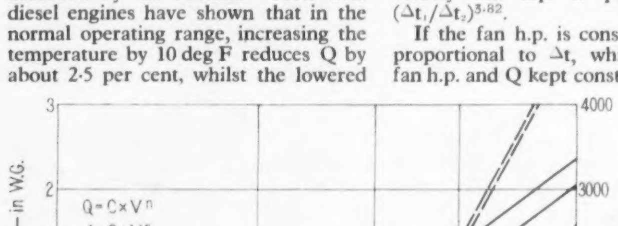


Fig. 1. Performance of continuous gill and tube matrices

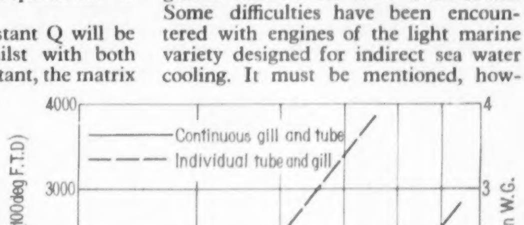


Fig. 2. Performance of individual tube and continuous gill and tube matrices

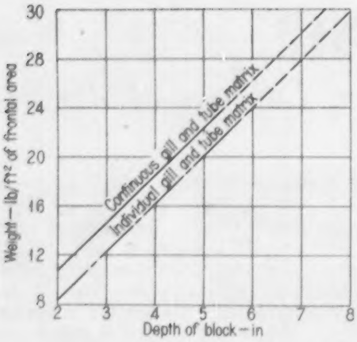


Fig. 3. Weights of radiator matrices

ever, that early in the war all British fighting vehicles were pressurized to 5 lb/in². Later, this was increased to 8 lb/in² with some tanks, whilst nearly all W.D. vehicles built since 1945 are pressurized to 10 lb/in². No difficulties were experienced in the operation of this very large fleet of vehicles, to a large extent powered by manufacturers' standard production engines, because of increased coolant pressures. Pressures of 5 to 10 lb/in², with diesel and petrol engines respectively, can be considered as completely safe with the majority of engines.

Radiators

At present two basic types of radiator matrices are used, the individual fin or gill and tube, and the continuous gill and tube type. The former may have tubes of any cross-sectional form to which are attached gills, each tube and its gills forming a separate unit. The latter is an assembly of coolant carrying tubes joined together by gills common to all tubes or groups of tubes. The suitability of each for a cooling system must be judged on the basis that the ideal radiator (Ref. 1) will be one which:

1. Occupies the smallest space, requires minimum fan power and has the least weight
2. Is mechanically robust with regard to accidental damage and effect of internal pressure
3. Is not easily clogged by dust, grass, or other foreign matter, and is easily cleaned
4. Has no intricate or unduly small coolant passages to become clogged by scale, products of corrosion or coolant impurities
5. Is of a shape that permits easy installation.

With regard to the first requirement, the performance of efficient single tube and continuous gill matrices are plotted in Fig. 2 for a constant air velocity of $V=30$ ft/sec and a water flow of 22 gal/(min)(ft width). At other air velocities the heat dissipation Q of the individual tube matrix concerned can be obtained from the relation Q proportional to $V^{0.48}$ to $V^{0.54}$, whilst for the continuous gill matrix Q proportional to $V^{0.65}$ to $V^{0.75}$. The pressure drop is proportional to about $V^{1.75}$ to $V^{1.85}$ for both types. It will be noted from Fig. 2 that Q is proportional to the 0·622 and 0·7 power of the block depth with individual tube and continuous gill units respectively, whilst Δp is a function of the 1·075 and 1·23 power respectively. To dissipate $Q = 1700$ B.Th.U/(ft²)(min)(100 deg F.T.D.) at an air velocity of 30 ft/sec will require a block depth of 5 in and $3\frac{7}{8}$ in for the individual tube and continuous gill matrix respectively, the relevant Δp values being 4·6 in W.G. and 2·8 in W.G. Assuming a fan efficiency of 60 per cent, the resultant fan h.p/ft² of frontal area will be 2·25 and 1·375 respectively. The respective matrix weights, including water, Fig. 3, will be 20 and 17·5 lb/ft² of frontal area. It is, of course, possible to obtain identical fan h.p. for either type by increasing the frontal area of the less effective matrix at the expense of space, weight and cost, always provided that the identical air flow velocity will be maintained through the rest of the system. That means, at the expense of further space requirements, so far as ducts and inlet and outlet apertures are concerned, throughout the system.

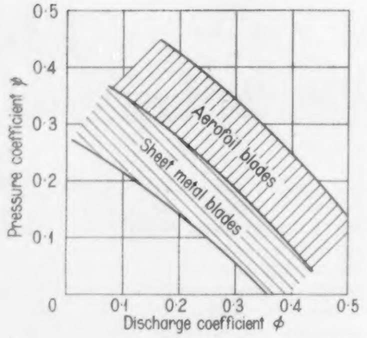


Fig. 4. Performance ranges of typical cast and sheet-metal fans

In the case of the second requirement the individual tube, because of its sturdy construction, is more robust with regard to accidental damage, whilst so far as internal pressure is concerned, both types stand up well to operational requirements.

A claim often made in favour of individual tubes is that they can be replaced separately. However, experience indicates that accidents to radiators causing damage to tubes are usually of a serious nature requiring far more repair than merely the change of a few tubes. In any case, continuous gill matrices can be sub-divided into individual elements, although even this seems scarcely desirable unless the matrix is too large for manufacture as a single block, or because of noise. With some continuous gill and tube matrices, a pronounced whistling noise becomes apparent as soon as the air velocity exceeds about 40 ft/sec. This noise appears to be caused by eddies shed behind the tubes in the form of a double row of vortices known as the Kármán vortex-trail (Ref. 2). It might be mentioned that the note emitted by wires in a wind is connected with the frequency of eddies discharged behind them and it has been verified experimentally that the frequency of

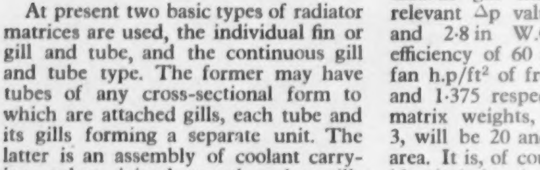


Fig. 5. Effect of straightener vanes on the performance of a 23 in diameter fan at 2,000 r.p.m.

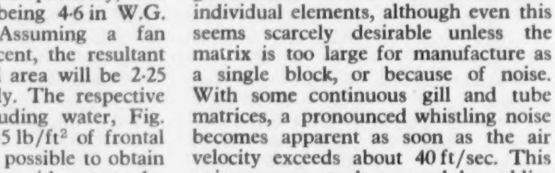


Fig. 6. Effect of fan speed on noise

the note heard is the frequency of the cast-off eddies. The rate at which the vortices are cast off the tubes is approximately $f=0{\cdot}22\ V/d$ where f=number of vortices/sec, V=air velocity past the tubes (ft/sec) and d=tube width (ft). The quoted value, 0·22, does not apply to every case. In any application, it depends somewhat on the velocity of flow but the value always lies between about 0·18 and 0·27. It is possible that under conditions of resonance, vortices may be shed simultaneously along the whole length of all tubes to produce a loud penetrating whistle.

Because of its superiority so far as the first requirement is concerned, the continuous gill and tube matrix merits increased adoption, particularly for installations where available space and, or, fan power are limited.

Oil cooling

This is scarcely a problem with engines in the lower output range. Generally effective sump cooling is all that is required up to 150 to 200 h.p. From 200 to 500 h.p. a simple individual tube and gill cooler will be best suited to meet general requirements. Above 500 h.p. the increased amount of heat as well as general installation considerations indicate that an efficient solution will be provided by the use of an oil-to-water heat exchanger (Ref. 3). With this the oil will be circulated through a heat exchanger and cooled by water, which in turn will be cooled in a radiator installed alongside the coolant radiator. The advantages of this system are: reduced pressure losses in the oil-cooling circuit; rapid warming-up of oil; warming-up of oil before starting. On the debit side is the necessity for an additional cooling circuit with its own water pump since the water must be some 50 to 80 deg F cooler than the oil and consequently cooler than the engine coolant. However, since the advantages obtained with such a system are very considerable, it should gain popularity, particularly with engines of high power output.

Fan performance

The most important problem at present faced by fan designers is that of noise. High pressure and flow values could be maintained by relatively small fans if only they could run at the necessary blade-tip speeds, but a limit is set to these not so much by strength considerations as by the emitted noise or whine.

The results of an analysis of a considerable number of fans designed during the last ten years are plotted in Fig. 4 in terms of non-dimensional coefficients. Here pressure coefficient $\psi=2\Delta p/\rho u_t^2$ and discharge coefficient $\varphi=c_m/u_t$, where Δp=pressure rise, ρ=air density, u_t=blade tip velocity and c_m=axial air velocity through the fan. All fans were tested without a nosepiece upstream of the hub, or a diffuser downstream of it. The hub: diameter ratio ν was in the order of 0·5 to 0·6. Thus, without adding the refinements required to ensure better flow before and after the fan and in turn increasing its space requirements, limits are set to the pressure rise by the fan tip speed. It is possible to improve the performance, particularly so far as efficiency is concerned, by the use of straightener vanes downstream of a fan as indicated in Fig. 5. The effect of obstructions placed upstream of the fan cowl on its performance are shown in Fig. 7.

Apart from an appreciable improvement in efficiency the use of straighteners is desirable to reduce kinetic losses of the flow with radiators mounted downstream of the fan and also when the air is turned round a corner downstream of the fan with the help of guide vanes which must be approached by straight-on flow. Since space is usually at a premium, streamlined hub nosepieces and diffusers are scarcely used and other methods must be considered to keep tip velocity u_t and noise to a minimum.

Fan noise

The fan noise can be as high as 100 phons at a tip speed of 150 ft/sec, rising to 116 phons at 375 ft/sec, Fig. 6. For the commonly occurring frequencies of 500-10,000, covering a range of about four and a half octaves, equivalent loudness in phons is very nearly given by the sensation level in decibels. To provide a basis for comparison it may be mentioned that a loudness of 40 phons is produced by tearing paper, about 60 phons by a vacuum cleaner, 90 to 100 by a pneumatic drill, 100 by a motor cycle, 110 in a boilermaker's shop and 120 due to the airscrew of an aircraft engine at 12 ft distance, whilst 130 phons are on the threshold of pain.

Plotting the data of Fig. 6 to logarithmic scales shows that the sound intensity is proportional to $\sqrt[4]{u_t}$. If I_1 and I_2 are two known values of sound intensity, then the difference of intensity level in decibels

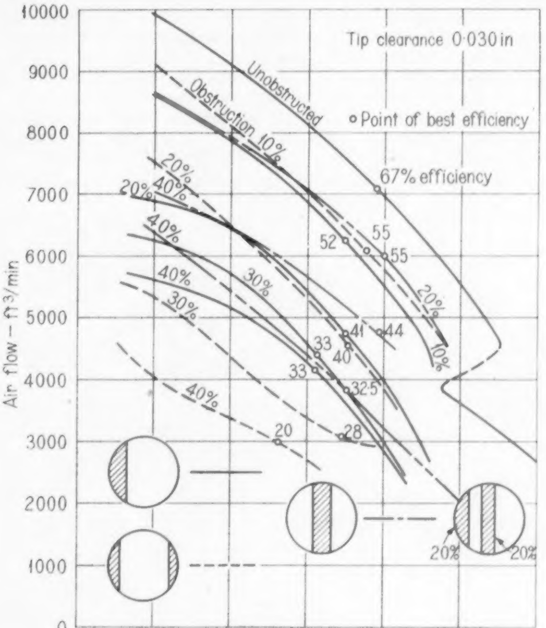


Fig. 7. The effect of obstructions upstream of fan on performance (23 in diameter fan at 2,000 r.p.m.)

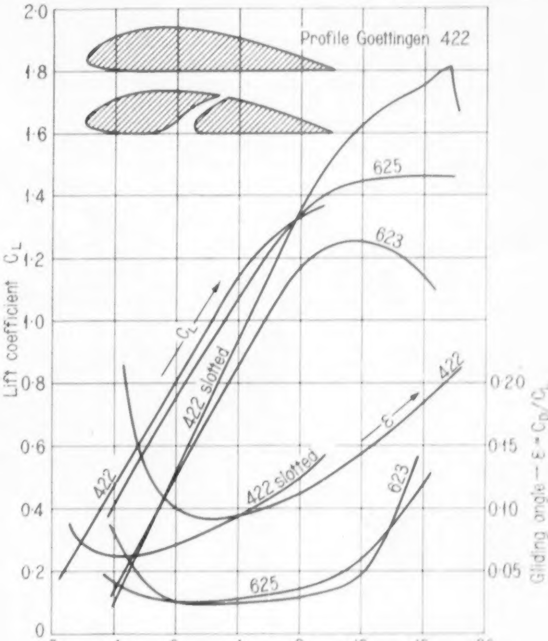


Fig. 8. Performance data of Göttingen aerofoil blade sections

(dB) is $10 \log_{10} I_1/I_2$. An increase in intensity level of 1 dB means that the intensity has increased in the ratio of 1·26 : 1 (that is, antilog 0·1 : 1), 2 dB means ($1{\cdot}26^2$):1 and 10 dB means ($1{\cdot}26^{10}$) : 1. It should be mentioned that decibels represent merely the logarithm of an intensity ratio—they do not constitute a measure of loudness. Thus for a rise in intensity level from 100 to 116 dB, $10 \log_{10} (I_1/I_2) = 16$ or $I_1/I_2 = 40$, that is, the intensity has increased 40-fold. At the same time the fan speed increased $375/150 = 2{\cdot}5$ times and the pressure (for a given system) $2{\cdot}5^2 = 6{\cdot}25$ times. Since by definition decibels are proportional to $10 \log_{10} p^2$, the noise intensity will be proportional to u_t^4, or in the present case $2{\cdot}5^4 = 39$.

Fan noise appears to be due to eddies caused by the drag of the blades and shed at the trailing edges, the interference between these eddies and objects downstream of the fan, pulsation of the flow due to unloading of the blades passing stationary objects, and blade vibrations causing disturbances in the flow. It is also possible that the noise is amplified by resonance of the air column between the blades. The mechanism of the eddy-shedding behind the blade of the fan would also appear to follow that of the double row of vortices of the Kármán vortex-trail. Since the vortex strength is proportional to the drag D which in turn is proportional to u_t^2 (other variables remaining the same) noise may be assumed as proportional to $10 \log_{10} D^2$. If this were the case then the noise could be reduced by increasing the number of blades. On the other hand this would, as likely as not, increase the frequency of the noise and this might be more objectionable than a greater intensity at lower frequency. Flow separation at the blades is indicated by a change in the noise. As the stalling point of the blade profile is approached, the noise increases gradually until suddenly it changes to a loud howling sound as the flow breaks away from the blades. A further factor that will possibly affect fan noise is the proximity of the blades to each other, that is, whether the leading edge of a blade caught up with the eddy leaving the trailing edge of the preceding one.

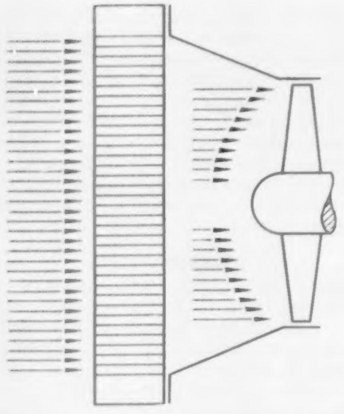


Fig. 11. Air flow distribution upstream of fan

It will be noted from these considerations that the subject of fan noise calls for a very considerable amount of experimental and theoretical investigation. In the meantime, general experience shows that to prevent undue noise the tip speed u_t should not exceed 200 to 250 ft/sec. To achieve improved flow-pressure performance within this limitation will mean an increase in the number of blades and the use of blades with improved values of lift coefficient C_L. The number of blades is limited by the fact that as soon as the blade chord : pitch ratio exceeds unity, the interference between blades reduces the gain in pressure which is otherwise proportional to the number of blades. In short, a region of diminishing return is entered. The value of C_L might be improved by using symmetric slotted aerofoils based on the principle of the Handley-Page slotted wing.

Sheet-metal or cast fans

On the score of performance (Ref. 5) the answer is provided by comparing Fig. 8 with Fig. 9. The former shows the lift coefficient C_L *versus* gliding angle ϵ data for various aerofoil profiles whilst the data of the latter applies to sheet-metal profiles. In either case, the curves are for infinite aspect ratios, that is, they are applicable for fan blades. A comparison shows that similar values of C_L can be obtained with either type of blade, but the region of low ϵ values, that is, high efficiencies, is wider for aerofoil blades. Since fan rotor efficiency in decimals is given by $\eta = 1 - (\epsilon/\phi)m$, see Fig. 10, to achieve high η it is necessary to maintain high ϕ values. Since $\phi = c_m/u_t$ this in turn means low rotational velocities, high axial velocities—that is, a large diameter hub—or a combination of both. Thus, although similar results can be achieved, the design conditions must be known more precisely for sheet-metal fans, which also will be more sensitive to the changes in operating conditions, that is, changes in pressure losses. However, if the fans are carefully designed with reference to the blade attachment to the hub in the case of sheet-metal units, equal results can be expected from the two types.

If a relatively small number of fans is required, sheet-metal fans should be given preference on the score of costs. The performance should be satisfactory provided the Reynolds number of

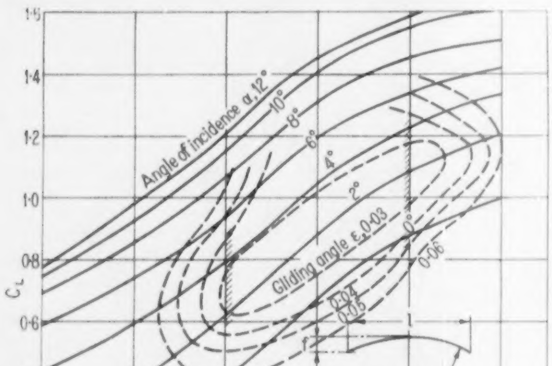


Fig. 9. Performance data of sheet-metal blade sections

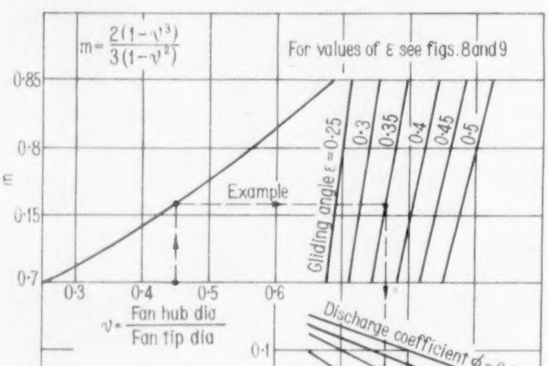


Fig. 10. The effect of hub : diameter ratio ν, gliding angle ϵ, and discharge coefficient ϕ on fan efficiency

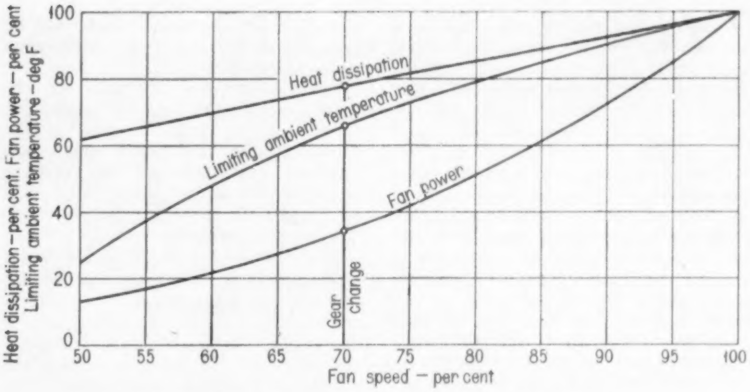


Fig. 12. The effect of fan speed on system performance

the flow past the blades exceeds about 80,000 to 100,000. In principle, the use of aerofoil sections is less conducive to the generation of noise. On the other hand, the tip speed can be reduced if the number of blades is increased. However, limits are set in this direction to cast fans by the fact that expensive dies must be used as soon as blade chord : pitch ratio equals or exceeds unity. With welded sheet-metal fans the number of blades used is not limited by these considerations.

A point sometimes overlooked in purely theoretical considerations of fans located downstream of radiators is indicated in Fig. 11. With the area of radiators usually greater than that of the fans, and particularly with fans having a large hub:diameter ratio, the axial air velocity at the tip will be considerably in excess of that at the hub if a uniform air velocity is desired through the radiator. The resultant flow distribution may even justify use of constant pitch, constant chord blades.

Multi-stage fans

The use of a two-stage fan would, for the same air flow, double the pressure head, or conversely it will be possible to run the fan at $1\sqrt{2}=0{\cdot}707$ of the original speed. Since there will be two rotors the noise intensity will be reduced to a slightly smaller extent.

The main drawbacks of two-stage fans are the cost and space requirements. In view of the relatively low pressure heads usually required it is possible to design the rotors alike, thus reducing costs. To ensure identical flow conditions straightener vanes must be provided between the rotors, and to reduce noise the distance between rotors and stator should be about 1 in. Thus even without straightener vanes downstream of the fan the overall space requirements will be about double that of a single-stage fan with straighteners.

Thus better performance can be achieved by improving flow conditions up and downstream of the fan, use of straighteners, slotted aerofoil blades and finally increasing the number of stages.

Fan drive

With exceptionally lively (high power, low moment of inertia) engines driving through multi-speed mechanical transmissions, as well as fans with high moment of inertia, high stresses are encountered by the fan-drive components. With belt drive, the "snatch" loads can appreciably reduce the life expectancy, particularly if the belts are located downstream of the radiator in the hot air stream. With high-powered diesel-hydraulic or mechanical vehicles shaft-driven fans would seem to be promising in conjunction with overload slipping clutches. In addition, a two-speed fan drive might be desirable when considering the power required to drive the fans, since cooling systems must be designed for maximum ambient temperatures. In the case of a cooling system pressurized to 10 lb/in^2 the water will boil at 239·5 deg F. Assuming a temperature drop through the radiator of 10 deg F, ambient temperature of 100 deg F, and a temperature reserve of 10 deg F, the air to mean coolant temperature difference will be $\Delta t=239{\cdot}5-100-9{\cdot}5-10=120$ deg F. Since the amount of heat dissipated by the radiator is a function of $V^{0\cdot74}$ the amount of heat dissipated at, say, 70 per cent of fan speed, i.e. air velocity, is $0{\cdot}7^{0\cdot74}=0{\cdot}78$. Accordingly, $\Delta t=120/0{\cdot}78=154$ deg F, and consequently the limiting ambient temperature $=239{\cdot}5-154-9{\cdot}5-10=66$ deg F. At the same time the fan power is reduced to 34 per cent of the original value, Fig. 12. Somewhat similar conditions apply to other combinations of cooling system performance and air temperatures (Ref. 5). This shows that both fuel consumption and drive wear-and-tear can be reduced by the use of a two-speed fan drive, maximum fan speed being used in summer, whilst 0·7 maximum speed should be sufficient throughout the rest of the year.

Thermostats

The main drawbacks usually associated with what might be termed standard bellows-type thermostats are their pressure sensitivity (the operating temperature will be influenced by surrounding pressure coolant) and relatively high pressure losses usually due to poor design of the housing passages. The first drawback can be overcome by employing special wax-actuated operating elements, whilst careful attention to design should enable pressure losses to be reduced.

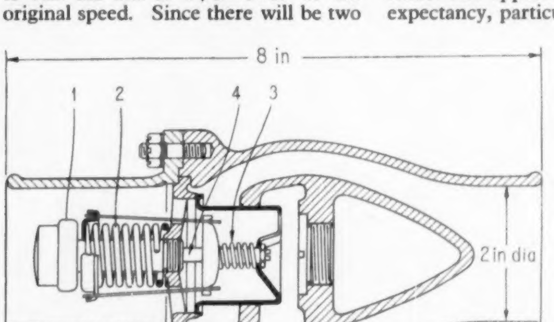


Fig. 13. Thermostat with pressure-insensitive element. Housing designed to reduce pressure losses

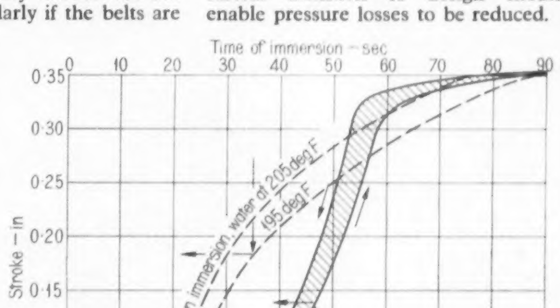


Fig. 14. Performance curves of the thermostat in Fig. 13

Thermostats incorporating pressure-insensitive elements, Fig. 13, are now made in this country. The thermostat incorporates the element (1), working against the return spring (2). Should the element continue to expand after the valve comes against the stop, thus closing the by-pass passages, the stem (4) will compress the spring (3) without moving the valve. To reduce as far as possible the losses encountered by the coolant leaving the valve, the passage has been proportioned here to ensure gradual expansion so that the change of section should correspond to that of a diffuser with an included angle of 10 deg. The performance of units of the type, shown in Fig. 14, can be regarded as generally satisfactory.

The future of cooling systems

The recent appreciable improvement of the specific power output of vehicle engines means that the amount of heat to be dealt with by the cooling system has been increased. Whilst the number of B.Th.U/h.p. to coolant will decrease if supercharging is employed the total number of B.Th.U. will increase. Unless the overall effectiveness of the cooling system can be improved the space or power requirements, or both, of the cooling system will necessarily be increased whilst the space requirements of engines might remain virtually the same, despite their enhanced power output. To ensure that the development of cooling systems matches that of the engines it is suggested that the following lines of attack merit careful consideration:

Pressure cooling at 5 to 10 lb/in^2. This will reduce radiator size or the power required by the fan, or both.

Careful proportioning of air passages, particularly immediately before and after the fan. Use of a semi-spherical hub boss upstream and a diffuser downstream of fan. This will improve fan efficiency as well as the pressure coefficient ψ.

Straighteners downstream of fan. These will substantially increase the pressure coefficient or, alternatively, by maintaining the same coefficient as a single stage, but at lower speed, reduce the noise.

Pressure - insensitive thermostats. These will ensure more satisfactory performance, with particular reference to pump performance. Only if concentrated efforts are made to develop components along the above lines will it be possible for the cooling system to meet the requirements which will be imposed as the result of continuous engine development.

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AMERICAN ENGINES

A Summary of 1954 Programmes

VERY high maximum brake horse power is quite the most outstanding feature of engines developed in the United States of America for 1954 models. Outputs well in excess of 100 h.p. are common and Packard are producing one engine that develops 212 h.p. at 4,000 r.p.m. This Packard engine has a long stroke in relation to bore diameter, 4½ in to 3 5/16 in, but the general trend in America is to employ over-square engines in a more exaggerated form than in this country. For example, there are two Buick engines with a stroke of only 3·2 in and a bore of 4·0 in.

Ford

There are seven Ford power units, two for passenger cars and five for trucks. All have overhead valves. The engines for passenger cars comprise a revised version of the Ford Six and a newly designed V-8. These, as well as the truck engines, have valve rotators on the inlet and exhaust valves. All seven engines have a 7·2:1 compression ratio. This ratio in conjunction with high turbulence combustion chambers is said to give remarkably low energy loss.

The crankshaft on the new V-8 is cast in alloy iron. It is shorter, stiffer and 16 lb lighter than the design previously used. More bearing overlap is provided, and this, of course, contributes to greater torsional rigidity. In fact, this engine is so free from inherent torsional vibration that the usual torsional vibration damper is not necessary.

Aluminium alloy pistons with steel struts are used for all seven engines. Those for the passenger car engines have three rings, including an expander-type oil-control ring. Truck engines have heavier pistons. Non-surge valve springs, with damping coils on the lower ends, are used in all engines. There are integral valve guides bored direct in the head. It is claimed that they reduce critical valve temperatures by more than 100 deg F. They provide a full length oil-bearing surface for the valve stem. To prevent leakage of oil, both the inlet and exhaust valves are fitted with simple but effective Neoprene shrouds.

Particular attention has been paid to the manifolding on the new V-8. A T-section over-and-under intake manifold is employed. It has well-balanced passages to ensure equal distribution of the mixture to all cylinders. This design has been adopted to give the largest possible port areas. When the engine is cold, exhaust gases are bypassed through a central chamber round the passages to warm the incoming mixture.

Buick

There are six engines in the Buick range for 1954. They are all 90 deg, V-8. Two have 3·625 in bore and 3·2 in stroke; the other four have a 4·0 in bore with a 3·2 in stroke. The compression ratios vary from 7·2:1 to 8·5:1, and the maximum b.h.p. from 143 at 4,200 r.p.m. to 200 at 4,100 r.p.m. Points of interest in these engines are that interchangeable hydraulic valve lifters are standard on all and the piston ring arrangement is similar for all. Bevel taper compression rings, 1/16 in wide, are fitted. The oil control rings are of multi-piece rail type, comprising four parts, two steel side rails, a corrugated steel spacer and a spring steel expander, the complete assembly being cemented together with an adhesive that dissolves when the engine is run.

Packard

There are four basic engines in the Packard range. They are a Clipper Special developing 150 b.h.p. at 4,000 r.p.m.; a Clipper De Luxe developing 165 b.h.p. at 3,600 r.p.m.; a Cavalier developing 185 b.h.p. at 4,000 r.p.m.; and a Packard developing 212 b.h.p. at 4,000 r.p.m. The respective compression ratios are 7·70, 8·0, 8·0 and 8·7:1. In contradistinction to other American designs these Packards all have stroke/bore ratio considerably greater than unity. They also differ in that they are in-line whereas all the Buick and five out of seven Ford engines are 90 deg V-8.

BELGIAN BODYWORK

A Review of Buses and Coaches Exhibited at the Brussels Show

EVEN among Continental bodybuilders, Belgian manufacturers of public service vehicle bodywork are considered to favour highly individualistic, extravagant exterior and interior styling, although revealing few signs of originality in structural design. Certainly the buses and coaches displayed at the Brussels Show in the main supported this opinion, especially as of the two innovators among Belgian bodybuilders, Brossel Frères and Ateliers Metallurgiques, only the former displayed examples of their products. The latter, the only concern in Belgium so far to have developed a successful integrally constructed bus, were not represented among the 17 stands devoted to bodybuilders. Moreover, the Brossel exhibits were based on the newly developed rear-engined chassis which was shown with bodywork of quite conventional inspiration.

Reasons for the special approach of Belgian bodybuilders to the problem of producing bodywork for buses and coaches are not far to seek. The market is a highly competitive one, in which both the French and the Dutch enter. Chausson, in France, and Verheul, in Holland, for example, have both produced chassisless designs which have found favour in Belgium where, no doubt, the low initial cost and long-wearing properties of these standardized vehicles in series production offer advantages which the large operator cannot afford to ignore. A fiscal policy, aimed at making the country more self-supporting in vehicle production has, however, had its effect, and among the vehicles displayed were two urban service buses with bodywork based on the standard specification laid down by the Chemin des Fers Vicinaux as part of its programme of expansion of road services. Numbers of these bodies have been built for mounting on chassis varying in size from the Chevrolet to the Magirus-Deutz.

Small operators, who form the backbone of the country's passenger transport industry, are, however, little interested in standardized bodywork. There is sharp competition between operators for the traffic available, and each one vies with the others in attempting to procure the more resplendent vehicles. Thus, with the exception of the few large orders placed by municipal and railway-owned bus undertakings, the bulk of the Belgian bodybuilder's production is fundamentally one-off in type. Furthermore, as the Belgian operator may select the chassis for his bus or coach from among the products of over 40 Belgian chassis manufacturers, it is almost impossible for the bodybuilder to devise a body framing which will adapt itself to such a variety. In Britain where, at most, there are 15 public service vehicle chassis makers, the position is quite different.

Legal requirements also demand considerable ingenuity on the part of the bodybuilder. In contradistinction to British Construction and Use regulations, Belgian law applies no arbitrary maximum axle loading figure. Each chassis is the subject of investigation by the appropriate department of the Ministry of Public Works, which, after consultation with the operators, manufacturers and bodybuilders, issues a Procès Verbal d'Agréation (acceptance certificate) that lays down approved maximum axle loadings for the particular chassis, which must in every case be respected. A maximum "poids au sol" is also determined, based on the weight of the chassis with full tanks, spare wheel, bodywork and accessories, passengers and baggage. Additional accessories may not be fitted to the vehicle after it has been completed and accepted, unless the requisite margin of weight is available. It is on the basis of this certificate, which is issued for each type of chassis available in the country, that the bodybuilder is able to decide how many seats, how much equipment, and what type of body may be fitted to the chassis. Since the permitted axle loadings are rigidly limited, the same type of body may not be adaptable to two similar, although not identical, chassis. It is possibly for this reason that some British underfloor-engined chassis are provided with bodies with notably fewer seats at the front of the body than is usual in this country. The other means whereby the bodybuilder may get the required weight distribution between the axles is by extending the rear overhang. In the past this has resulted in vehicles with an overhang at the rear almost equal to the wheelbase, but the law is now being revised

A non-standard version of the Chausson underfloor engined, chassisless coach for extremely long distance service

The Bostovo body for the Leyland Royal Tiger shows signs of original thought on the subject of coach styling, while at the same time satisfying the national taste for abundant decoration

The vertical engined Chausson coach has a wide entrance ahead of the front axle. Flat, glass panels are used instead of the more normal curved panels, and they give exceptionally good all-round visibility

Many Belgian body builders are influenced by American concepts of private car styling, as can be seen from this Veleure body on a Scania Vabis chassis

This Volvo forward engined coach, with bodywork by Van Hool, was one of twelve examples of this body builders work displayed at the Show. In this vehicle, a similarity to current American car styles can be clearly distinguished

on this matter. At the moment, irrespective of wheelbase, a rear overhang of up to 9 ft 6 in is permissible in every case provided the vehicle has an overall length of 32 ft 10 in. In future, the absolute maximum rear overhang will be extended to 10 ft 6 in or 60 per cent of the wheelbase, whichever is the lesser. This extension is already permissible on receipt of authorization from the Ministry, and in future a rear overhang of up to 65 per cent of the wheelbase will be permitted in special cases. Other legal requirements which affect the design and construction of bodywork in Belgium are those concerned with entrances and exits. A front entrance, alongside the driver's seat, is a legal requirement and usually a second entrance, behind the rear axle, is also added. Then there must be, in addition to the main entrances, one emergency exit for each 18 passengers. To meet certain international requirements, notably the Dutch emergency exit laws, most bodybuilders provide one or two sliding emergency panels in the roof, which may, of course, also be sunshine roofs. The difficulty of devising a robust body, capable of satisfying the undeniably arduous operational conditions, of such a length and with so many unavoidable gaps in the body is obvious.

It has been proved, at least by F.N. with their integral two axle trolleybus described later, that a structure of this type can be devised to meet most needs. But standardized bodies' designs implicit in integral construction are unacceptable by the one-man operators who constitute a high proportion of the Belgian passenger transport industry. The coachbuilder therefore tends to employ only those features of integral construction technique that can be adapted easily to non-standard productions. All-metal construction is therefore essential, both from the point of view of producing a stable body despite the legal requirements in respect of entrances and exits, and from the point of view of production, for most bodybuilders employ machines for forming the required shapes. This facilitates the construction of a widely varying range of bodies, without requiring the employment of a comparatively large number of skilled operatives, such as joiners. In itself the use of all-metal structures implies a degree of standardization, especially in regard to body shapes, but to meet the varying requirements this entails the use of large quantities of polished mouldings and decorative panels at the front and sides of the body. Another drawback of the favoured type of construction is the weight penalty. However, as economy is a poor second to passenger capacity in the eyes of the Belgian operator, this is not considered as serious as it would be in Britain.

Some indication of the diversity of demand catered for by Belgian bodybuilders is provided by an examination of the vehicles displayed by Joncheere (Carrosserie), Beveren-Roulers, who exhibited no fewer than 22 different examples of their products. These included an A.E.C. Regal Mk IV 61-seat coach, in which 14 of the seats were folding gangway seats; a Bedford 37-seater; two Chevrolets; three Brossels; two underfloor-engined and one forward-engined Guy; two rear-engined standardized Magirus-Deutz buses; two Seddons with vertical underfloor engines; two forward-engined Mercedes (one bonneted); one Unic; one Scania-Vabis; a bonneted Borgward; and a Henschel with the engine located vertically and transversely ahead of the front axle.

In addition to bus and coach bodywork, Joncheere also produces all-steel cabs for F.N., and steel bodies for Bedford trucks. The cabs are representative of the best in current pressed steel design; folded box- and channel-section framing, relieved for lightness, forms the basis of the cabs, which are panelled with pressed steel. The floor, foot-board, dash and seat boxes form part of the stress bearing structure.

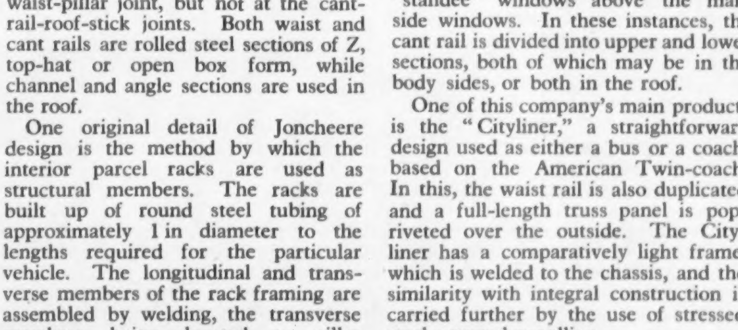
Except in the event of an operator requiring a body with a maximum seating capacity, for a chassis with a limited rated payload, the bus and coach bodies are also of steel construction, light alloys being used only in rare exceptions. For chassis without outriggers, the bodies are built up on light, channel-section cross-bearers, welded to the top flanges of the frame side-members. Otherwise the pillars are welded to the chassis outriggers, so forming an integrated structure. Where cross-bearers on top of a chassis are used, the pillar-cross-bearer joint is stiffened by the addition of a large steel gusset plate, welded between the lower flange of the cross-bearer and the pillar. Similar gussets are found at the waist-pillar joint, but not at the cant-rail-roof-stick joints. Both waist and cant rails are rolled steel sections of Z, top-hat or open box form, while channel and angle sections are used in the roof.

One original detail of Joncheere design is the method by which the interior parcel racks are used as structural members. The racks are built up of round steel tubing of approximately 1 in diameter to the lengths required for the particular vehicle. The longitudinal and transverse members of the rack framing are assembled by welding, the transverse members being located at pillar stations. Outside the longitudinal tube a further member is added. This is also a round tube and is welded to the main framing at the pillar stations at approximately 30° to the vertical. At the upper ends these diagonal members are welded to the outermost roof sticks, and the lower ends to the cant rail. Below the racks the diagonals are swept in to clear passengers' heads. The effect of this arrangement is to form a strong reinforcement between the roof and body sides. Nylon net, slung between the longitudinal outer tubing and the interior cant panels, completes the racks.

Except in the case of buses, all exterior panelling is formed as far as possible from single sheets of steel of about 18 gauge. Sheets up to 15 ft long are used, and frequently adjoining panels are seam welded together to provide an exceptionally clean interior surface. The panels themselves are spot welded to the pillars and to intermediate bracing members. Solid rivets are widely used for bus bodies, the panels being then cut in bay lengths and joints concealed by cover strips up to 2 in wide.

Van Hool and Sons, Koningshooikt, had 12 bodies at the show. In the main, the methods of construction employed by this company resemble those of Joncheere, except that all framing is composed of steel tube. Drawn, square section tubular pillars, roof sticks and sill rails are used, but the cant and waist rails are fabricated sections composed of a square section tube inside a flanged angle section. The cant rail is a particularly deep section in this company's products unless the customer's specification calls for glazed cant panels or small "standee" windows above the main side windows. In these instances, the cant rail is divided into upper and lower sections, both of which may be in the body sides, or both in the roof.

One of this company's main products is the "Cityliner," a straightforward design used as either a bus or a coach, based on the American Twin-coach. In this, the waist rail is also duplicated and a full-length truss panel is pop-riveted over the outside. The Cityliner has a comparatively light frame, which is welded to the chassis, and the similarity with integral construction is carried further by the use of stressed steel external panelling.



The FN trolleybus has an all-welded integral structure in which channel sections predominate

Wide jack-knife doors were used on the bus version of the Cityliner exhibited. This was based on a Leyland Royal Tiger chassis, and its unladen weight was approximately 8 tons 10 cwt, not an unsatisfactory figure for a 37-seat bus capable of carrying 70 or more passengers. A neat point in this vehicle was the design of the parcel racks, which were framed in small diameter tubes to which perforated sheet metal was riveted to form the racks. A similar perforated sheet metal duct along the offside of the body carried the output of the Webasto heater with which this vehicle was fitted. As an alternative, Van Hool offer their own heating system, in which heat is derived from a water jacket surrounding the engine exhaust pipe.

Typical of the smaller bodybuilders' products were the three coaches displayed by Remi-Desot, Git-Roulers. Here, again, rolled steel sections are used for the body framing, but light alloy panelling is employed, single sheets being used as far as possible. This bodybuilder uses a curved pillar, the widest chord of the curve coinciding with a point adjacent to the passengers' shoulders. The interior trim found in this exhibitor's vehicles was exceptionally well carried out. On one, the seats were trimmed in unpleated leather, in contrast to the piped and fluted lizard-skin upholstery in one of the other vehicles on the stand. Like most Belgian bodybuilders, Remi-Desot use the same curved glass panels in both the front and the rear screens. British bodybuilders have been reluctant to use double-curved glass, no doubt because of the cost. The use of four identical screens in one vehicle is one way of amortizing this cost.

Another way of overcoming difficulties in this direction was seen on three of the four Chausson integral buses on show. Although the front panelling of these vehicles is well curved, the windscreens themselves are composed of four flat glasses, joined by thin rubber glazing. Outstandingly good visibility is thus achieved, although the front structure is more complicated than is usually the case, the entire front of the body being double-skinned, with stressed interior and exterior panelling. Much progress has been made by Chausson with their integral design, now available in two forms, with either a forward vertical or central horizontal engine. The second type, shown as a coach for long distance journeys (actually Stockholm-Barcelona), revealed a hitherto unexplored advantage of large scale production of standardized bodywork.

Compared with almost all other coaches on show, the Chausson underfloor-engined coach had a particularly clean finish. In this design, the front and rear panelling are assembled from a small number of pressed steel panels, the same glasses being used front and rear, with different panels at the front for the headlamps. The entire side panelling between the doors (there are four in the standard version, two each side) consists of one pressing between the waist and sill rails. The result is a standard of finish comparable with that of present-day private cars.

In complete contrast with this was the Bostovo body on a Leyland Royal Tiger chassis. This was clearly a "custom-built" body, with many attractive features, including pressed interior luggage racks slung from the roof instead of from the body sides and an exterior line which was nothing if not original. The finish, however, was not so commendable. A Scania-Vabis displayed by Verleure, also showed some of the defects of the individually built body, especially in the design of the radiator grille which was gaudy, in the current American private car manner. The interior finish of this vehicle was quite admirable, however. Like Verleure, all the Belgian bodybuilders derive their inspiration for body styling from American car styling. Some coaches, in fact, are deliberately designed to resemble high-quality American cars; but the styling which is appropriate to a 15 ft long passenger car is not always suitable for a 35 ft long forward control coach.

The Belgians follow American technique in bus body structural design, too, as instanced by the Van Hool Cityliner. But the F.N. earlier referred to is of European inspiration. A model of this integral trolleybus was displayed, and revealed many novel features which were not visible in the complete vehicle displayed at an earlier Brussels show. The underframe was composed of deep transverse channel sections, the four main transverse members being located at the spring hanger stations and spaced by light, tapered top-hat longitudinals. These longitudinals were not continuous, longitudinal rigidity being provided by the body side structure. This is based on 7 in wide open box-section pillars welded to the main cross-members which fit inside the open part of the pillars. Around the wheel arches, and between the waist and sill rails, a triangulated framework is formed of top-hat and Z-sections, while the massive cant and crib rails are of flanged channel section.

The diesel engined coach on the Borgward stand had a special body of all-metal construction by Jonckheer

NEW PLANT AND TOOLS

Recent Developments in Production Equipment

THREE additions have recently been made to the Cleveland range of single spindle automatic machines. The first of these is the 4¼ in "Dialmatic" model AB. It is a new and larger capacity version of the established 2½ in and 3 in AB Clevelands; it is illustrated in Fig. 1. The others are single spindle automatics of new design known as the 2½ in and the 4¼ in AW models. The principal difference between the AW and AB designs lies in the turret tool feed drive. Variable forward and return turret feeds are obtained in the new models through automatic settings of an improved and simplified mechanical friction roll drive, whereas in the AB models they are obtained through an electric drive.

All three machines have high-speed Geneva turret index; geared anti-friction spindle head, and wide, flame hardened cross slides independently operated by easily adjustable drums. In addition they have universal camming, rapid hand crank stock feed adjustment and oil feed through turret. They also embody a toggle-type chucking mechanism with three chucking fingers and a specially designed master collet with quick change pads.

The principal particulars for the 2½ in model are:—spindle speed range 69 to 1,920 r.p.m.; number of spindle speeds 40; stock feed stroke 10½ in; turning length 6 in; and idle motion time 11·3 seconds: for the 4¼ in models the particulars are:—spindle speed range 21 to 648 r.p.m.; number of spindle speeds 56; stock feed stroke 14 in; turning length 7⅞ in; and idle motion time 16·9 seconds. The Selson Machine Tool Company Ltd., Cunard Works, Chase Road, London, N.W.10, are the agents for these machines.

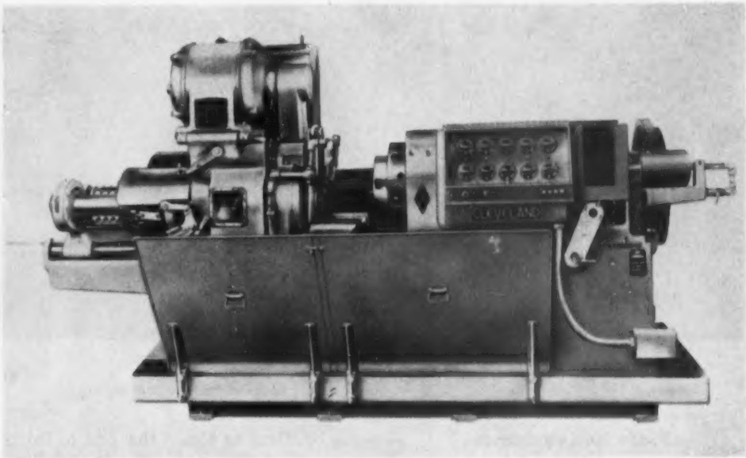


Fig. 1. Cleveland AB model Dialmatic
Selson Machine Tool Co. Ltd.

Chucking automatic

Illustrated in Fig. 2 is a chucking automatic designed and manufactured by Murad Developments Ltd., Stocklake, Bucks, for Fabrique Nationale d'Armes de Guerre, Liege, Belgium. It incorporates hydraulic actuation to all slides, with the hydraulic circuits controlled by solenoid-operated valves.

The spindle is carried in extra-precision pre-loaded Timken taper roller bearings at the front and precision roller bearings at the rear, allowing free float with rise in temperature. A dead length collet is fitted. It is opened and closed hydraulically. The collet is controlled by a lever and is interlocked electrically so that the machine cannot be started unless the collet is loaded and closed. An automatic brake comes into operation at the end of the cycle.

Provision is made to allow the spindle to be run with the slides out of action; alternatively, the slides can be put in operation with the spindle at rest. Independent front and rear cross slide units can be mounted at different positions along the bed. Each slide has independent controls for quick approach, feed, quick return and stop. Infinitely variable rates of feed are controlled through a dial at the rear of the machine.

A four position turret is mounted on the turret slide. The feed rate for each turret position is independently controlled by a separate dial. Quick approach, feed and quick return are provided for each turret face, and the point of change-over from quick approach to feed is adjustable by means of sliding dogs. The maximum traverse of the turret slide is 15 in. The cycle can be controlled for one, two, or four positions of the turret and the spindle speed can be arranged to change at any position of the turret.

In operation the operator loads, closes the collet, and presses the start button; the machine then carries out the working sequence and automatically stops at the end of the cycle. The first machine installed is producing in approximately half the guaranteed time per unit. In addition it has proved to be so accurate that inspection costs have been reduced by approximately 90 per cent in comparison with previous methods.

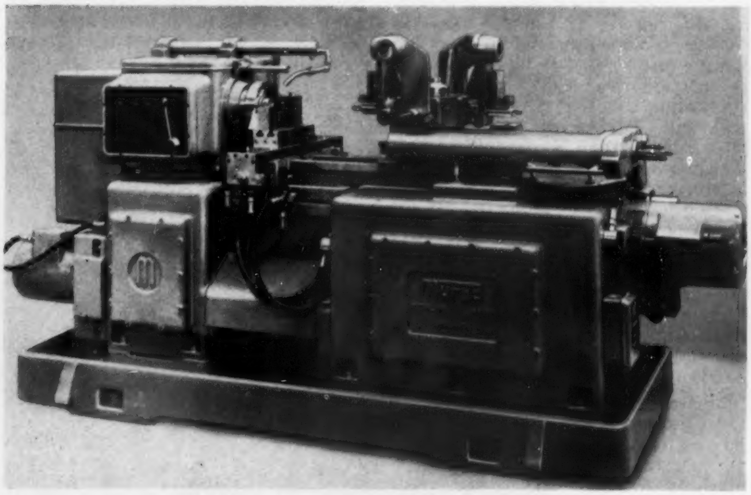


Fig. 2. Chucking automatic
Murad Developments Ltd.

Fig. 3. Power-driven straightener

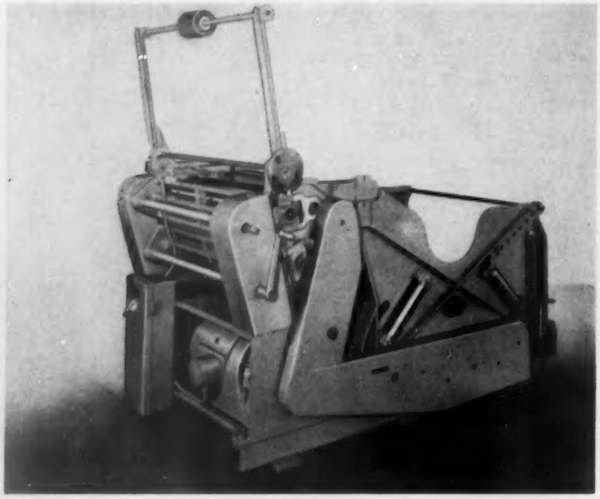


Fig. 4. Automatic coil cradle

Rockwell Machine Tool Co. Ltd.

Press feed equipment

Two recent additions to the range of British built U.S. Pressroom equipment are illustrated in Figs. 3 and 4. The equipment shown in Fig. 3 is a special power-driven straightener that is also designed to act as a feed. It will handle material from 0·063 to 0·093 in thick × 40 in wide at a maximum speed of 60 ft per minute. The actual operating speed, however, is governed by the type of application.

This unit comprises a set of power-driven take-in and take-out rolls and 12 straightening rolls, of which the lower six are power driven. It does not operate with a loop but feeds directly into the press. Power is supplied by a 5 h.p., 4:1 variable speed motor and there is no mechanical connection with the press. An air clutch is provided to disconnect the motor from the straightener; simultaneously two electric brakes are applied to the lower take-in and take-out rolls at each turn of the driving eccentric.

For each turn of the take-out rolls the maximum feed is approximately 15½ in. If so desired, the driving eccentric can be set for a shorter feed. Should more than 15½ in feed be required, the electric counter can be set to count from 1 to 400. After the desired count or feed length has been obtained, the counter opens the motor clutch and at the same time trips the press. As the ram of the press returns to the up position, a limit switch is closed and the counter resets itself and re-engages the motor clutch to re-start the cycle. An inching control is provided for adjusting the feed stroke and threading the stock through dies.

Fig. 4 shows an automatic coil cradle that will take coils up to 54 in O.D. and 40 in wide. It has four rest rolls instead of two and they are all power driven. This feature allows the operator easily to turn a heavy coil of material for threading into the pinch rolls. A reversing switch is provided to allow the operator to rotate the coil to bring the end of the stock into the starting position. As some types of material tend to wrap tightly away from the main coil, there is a slot in the side frames for use in prising the end of the material away from the main coil. Guides are provided for guiding the stock into a double set of take-out rolls. A 3 h.p. gear motor provides the power and the unit is arranged with mercury switch loop control mechanism. Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Road, London, N.W.2, are the agents for these units.

Flame cutting machine

An addition to the range of flame cutting machines designed and built by The British Oxygen Company Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1, is illustrated in Fig. 5. It is known as the Bantam and is the lightest machine in the range, weighing only 22¾ lb including the cutter. It can be used for cutting mild steel up to 2 in thick, and when used in conjunction with the radius bar it will cut circles from 3 in to 45 in diameter. For bevelled edges the cutting head is adjustable to allow an inclined cut to be made to any angle up to 45 deg. It is also adjustable for lateral movement and height.

The cutter uses the Cutogen one-piece nozzle, which gives clean machine finished cuts on slow curves. For cutting these curves the machine is steered by a handle at the rear and it can be made to follow curves marked on the plate surface. The castor trailing wheel can be locked for running on a track and can be disengaged by the simple adjustment of a locating screw for circle or profile cutting. A 3 ft light alloy track is provided with the machine; further lengths can be bought separately.

There is a reversing switch for straight cutting with the machine mounted on the track. To enable the nozzle to be quickly lined up over the work, a cross-traverse arm is fitted with a quick-action locking lever, a refinement not usually incorporated in a machine of this kind. Performance is, of course, dependent upon several factors, but the following examples are typical:—In straight line cutting $\frac{1}{8}$ in plate thickness can be cut at 130 ft/hr with a $\frac{1}{32}$ in nozzle; $\frac{1}{2}$ in plate thickness can be cut at 80 ft/hr with a $\frac{3}{64}$ in nozzle; and 2 in plate thickness can be cut at 40 ft/hr with a $\frac{1}{16}$ in nozzle. All steel parts are oxidized to prevent

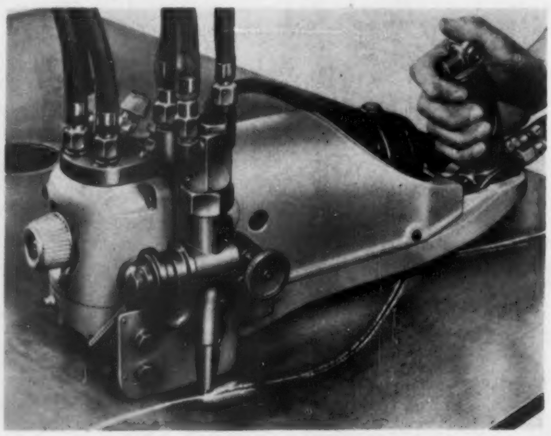


Fig. 5. Bantam flame cutting machine
The British Oxygen Co. Ltd.

rusting, the light alloy parts anodized and the attachments chromium plated.

High speed grinding spindle

The UVA Turbo-head high speed grinding spindle illustrated in Fig. 6 is driven by compressed air and embodies a speed-torque control not hitherto applied to air-turbine spindles. It enables the Turbo-head to run on compressed air at constant pressure in the whole speed range, thus giving higher torques at lower speeds. For example, one of these grinding spindles has an economical speed range of 60,000 - 100,000 r.p.m. with stepless variation of speed and torque by means of the built-in speed/torque control. In the lower speed range there is no loss in power and the torque is increased, which is exactly what is required for the larger diameter grinding wheels used at lower speeds. The drop in speed from no-load speed to on-load speed is in the order of 10 per cent. Therefore, the Turbo-head is a most efficient grinding machine.

Fig. 6. UVA Turbo-head high speed grinding spindle

Wickman Limited

Each Turbo-head is equipped with an electrically-operated tachometer that shows the actual speed of the spindle. As the drop in speed depends upon the load on the spindle, the speed indicator is an excellent means of controlling the grinding cycle. It denotes the load on the grinding wheel and allows the operator to keep the load at the correct value. This ensures safety and allows the maximum effective stock removal to be employed. As an example of the results obtained with the Turbo-head it may be mentioned that grinding of a hardened steel bush, $\frac{3}{4}$ in long, $\frac{5}{16}$ in diameter with a grinding allowance of 0·01 in, was completed in 20 seconds. The spindle was running at 82,000 r.p.m. and the speed decrease amounted to 12 per cent.

The Turbo-head is of extremely robust construction. It has a particularly rigid rotor carried in high-precision ball bearings of special design. To ensure rigidity, the tracks for the bearings are made with extreme precision direct on the spindle shaft. The air turbine in the spindle is of special design. It has very high efficiency with a consequent low air consumption even at high output and short grinding times. Turbo-heads are built for air supply at any pressure. At 80 p.s.i. the air consumption is about 11 c.f.m. of free air, while the air consumption is substantially constant over the whole speed range.

Because of its design the Turbo-head does not need a cooling system for the bearings. Even after several hours' continuous work the bearings remain at normal working temperature. This gives long bearing life and trouble-free running of the wheel-head. The Turbo-head is manufactured either built-in in a holder as shown in Fig. 6 or as a separate cylindrical spindle, in which case the tachometer and the air pressure regulating valve are supplied as a separate unit to be fitted on a convenient place on the grinding machine. Wickman Ltd., Coventry, are the sole agents for these machines in the United Kingdom.

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

The following meetings will be held during February:—

BIRMINGHAM CENTRE

Tuesday, 23rd February, 6.45 p.m. in the James Watt Memorial Hall, York House, Great Charles Street. Address by the Chairman of the Automobile Division, Professor S. J. Davies, D.Sc.(Eng.), Ph.D., Wh.Ex., M.I.Mech.E., "Combustion in Compression-Ignition Engines."

NORTH-EASTERN CENTRE

Wednesday, 17th February, 7.30 p.m. in the Chemistry Lecture Theatre, The University, Leeds. Address by the Chairman of the Automobile Division, Professor S. J. Davies, D.Sc.(Eng.), Ph.D., Wh.Ex., M.I.Mech.E., "Combustion in Compression-Ignition Engines."

NORTH-WESTERN CENTRE

Thursday, 18th February, 7.15 p.m. in the Engineers' Club, Albert Square, Manchester. Annual General Meeting followed by General Meeting. Paper: "Fretting Corrosion," by K. H. R. Wright.

SCOTTISH CENTRE

Monday, 15th February, 7.30 p.m. in the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. Paper: "Automobile Design in Retrospect," by J. A. Kemp, M.I.Mech.E.

WESTERN CENTRE

Thursday, 25th February, 6.45 p.m., in the Grand Hotel, Bristol. Paper: "The Application of Power-Assistance to the Steering of Wheeled Vehicles," by F. H. Heacock, M.I.Mech.E., and H. Jeffery, A.M.I.Mech.E.

The following meetings will be held during March:—

LONDON

Tuesday, 9th March, 5.30 p.m. General Meeting at Storey's Gate, St. James's Park, S.W.1. Paper: "Automobiles on Alpine Passes," by Herr Max Troesch.

COVENTRY CENTRE

Wednesday, 10th March, 7.15 p.m. General Meeting in St. Mary's Hall. Paper: "Automobiles on Alpine Passes," by Herr Max Troesch

DERBY CENTRE

Monday, 8th March, 7.15 p.m. General Meeting in the Midland Hotel. Paper: "Some Factors in the Performance of Fuel and Lubricating Oil Additives," by A. Towle, M.Sc.(Eng.), M.I.Mech.E.

LUTON CENTRE

Monday, 8th March, 7.30 p.m. General Meeting in the Assembly Room, Luton Town Hall. Paper: "Automobiles on Alpine Passes," by Herr Max Troesch.

NORTH-WESTERN CENTRE

Wednesday, 10th March, 7.15 p.m. General Meeting in the University, Liverpool. Paper: "The Manufacture and Properties of Automobile Suspension Springs," by C. J. Dadswell, Ph.D., B.Sc.(Eng.), M.I.Mech.E., J. E. Russell, M.A., and F. Fielding.

SCOTTISH CENTRE

Friday, 5th March, 7.30 p.m. General Meeting in the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. Paper: "Automobiles on Alpine Passes," by Herr Max Troesch.

KSS OIL CONTROL RINGS

A Two-piece Scraper Ring Developed by Hepworth & Grandage Ltd.

THE gradual adoption of the better quality oils by almost all diesel engine users has resulted in a great improvement in piston cleanliness; so ring sticking and sludging are, in most applications, no longer major problems. As a result, periods between overhauls are not dictated by the need to clean pistons and rings, but are determined by their rates of wear.

The relative rates of wear of the rings on a typical piston are shown diagrammatically in Fig. 1. It is well known that the top ring is subject to by far the greatest amount of wear, but the upper oil-control ring also deteriorates much more rapidly than the second and third compression rings. By chromium plating the top compression ring, its life has been increased until it is roughly equal to that of the second one. Therefore, the next step obviously is to increase the life of the oil-control rings until all five rings wear at the same rate.

With this end in view, Hepworth and Grandage Ltd. have made many tests with conventional oil-control rings of better wearing materials, but only small improvements have been obtained, and these were not commensurate with the increased costs. Clearly, the best results were likely to be obtained by chromium plating the ring, but the plating of slotted-and-grooved rings, while not impossible, is difficult. This led to the investigation into the design of various types of oil-control ring, with the object of finding a simpler type of ring, which could be more easily plated and which, at the same time, would be even more efficient in operation. Thus, the KSS ring, an assembly comprising two stepped rings with chromium plated lands, was developed.

The most widely used oil-control ring is the slotted-and-grooved type and the only significant change that has taken place over the years has been an increase, of about 400 per cent, of pressure per unit area between the ring and the bore. This has been effected by a progressive decrease in unit area, which undoubtedly will have tended to increase the rate of wear. However, this tendency has, to a certain extent, been offset by the improvements in lubricating oils, as well as by better mechanical design of engines and the development of more suitable materials for rings and bores.

Hepworth and Grandage Ltd. state that during their investigations a number of widely held theories were disproved. For instance, it has been found that there is no need for the corners at the top and bottom of the face, or land, to be sharp. Round or chamfered corners are necessary to prevent treeing in the chromium-plating process. So, much careful research was undertaken to show whether or not corners of these shapes adversely affected the oil-control properties of the ring. It appears that unless the approach angle is less than 2 deg there is no tendency for the ring to ride over the oil film; therefore, chamfered corners are perfectly satisfactory.

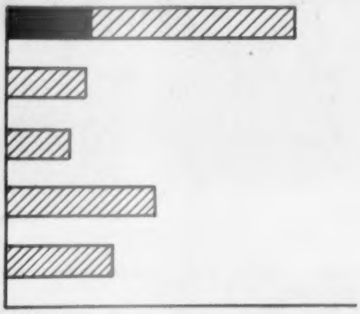
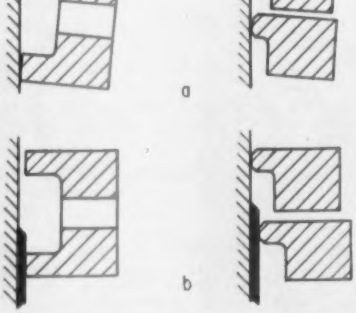


Fig. 1. Relative rates of wear of top, second and third compression rings and two oil control rings. The black area represents the rate of wear of a chromium plated top ring

Another belief that has been disproved is that much of the oil used by the engine passes round the back of the oil-control ring. In fact, the bulk of oil passing the piston ring goes between the face of the ring and the cylinder wall. Thus, pressure between the ring and the sides of the groove is ineffective as an oil control measure. Moreover, if it is of sufficient magnitude, it makes the ring sluggish in operation and prevents it from maintaining effective contact with the cylinder bore.

As a result of the experimental work undertaken it was found, as is often the case, that the simplest device is the best. One of the simplest forms of oil control ring is the stepped type, with a land of similar width to that of the more popular slotted-and-grooved rings. Two of these stepped rings in one groove are more effective than the slotted-and-grooved type, with its double land. This is because the two control lands are completely independent and remain effective even under conditions of piston rock, Fig. 2. Moreover, with the slotted-and-grooved type ring there is a tendency for the lower land to work more efficiently than the upper one in scraping the oil off the bore; this is also illustrated in Fig. 2.



a Effect of piston rock
b Effect of varying thickness of oil films

Fig. 2. Section of: left, a slotted oil control ring, and right, a KSS ring

It is well known that when a grooved ring without slots is employed, the upper land will scrape oil into the groove and, eventually, hydraulic pressure will lift the whole ring from the cylinder and make it ineffective. Therefore, it might be thought that some form of slotting would be necessary with the twin stepped ring arrangement. However, the thickness of oil film on the cylinder wall cannot be greater than the clearance of the piston in the bore, so there is a positive limit to the amount of oil that has to be removed. The lower ring of the pair removes most of this and passes it to the chamfer below the ring groove, from which it is drained through oil holes. Thus, only a small amount of oil remains to be cleared away by the upper ring of the pair, and this can pass easily through the clearance between the rings.

Hitherto, it has not been considered advisable to reduce the width of each land of the oil-control rings much below 0·040 in, because of the increased rates of wear that result. However, by chromium plating the land, and thus increasing its wear resistance, widths of 0·020 in or less are practicable. This doubles the pressure between the ring and the wall, and increases the effectiveness of the unit.

In addition to application to normally lubricated engines, another use for the KSS-type ring is where low viscosity oils are employed. With these oils, a marked improvement in fuel consumption is obtained, but generally at the expense of oil consumption. Therefore, means are sought of improving oil consumption without increasing piston friction. Piston friction is, to a major extent, dependent on the radial force of the ring, and is but little effected by the area of contact. It is, therefore, possible to increase the wall pressure with no resultant loss of mechanical efficiency, by reducing the width of the land. Moreover, the coefficient of friction of chromium on iron is appreciably lower than that of two iron surfaces rubbing together.

SALT BATH QUENCHING

Notes on American Practice for Isothermal Treatment

IN recent years in the U.S.A., for many applications an isothermal treatment has been adopted in place of the conventional heat-treatment or annealing cycle. The object of this is, of course, to allow the austenite to transform to the desired structure under closely controlled conditions. Because of the relatively high temperature at which the quench bath must be maintained, molten salts are the only practicable quenching media. A special type of furnace is necessary, since it needs not only a heating system to melt the salt but also requires a cooling system; both systems must be automatically controlled.

For this type of work the furnace always has a metal pot. The outside of the pot is often finned, and to extract the heat from the furnace, air under pressure from a motor-driven blower is forced round the outside of the pot. Furthermore, for quenching work, the salt must be properly agitated. For this purpose, salt pumps, with variable output, are mounted in a quenching furnace. Incidentally, the effect of the motion of the salt in extracting heat from the work is not always fully appreciated. With proper design it is very pronounced, and will actually permit a salt quenching furnace, operating at elevated temperature, to extract heat from the work over the critical range at a rate equal to, or exceeding, that which can be obtained from an oil quench tank equipped with equivalent circulating pumps.

There is a further major requirement in quench furnace design. If the work is heated in salt, as is generally the case, a certain amount of high temperature salt will be carried from the heating furnace into the quench furnace. This high temperature salt, generally a mixture of sodium and potassium chlorides, is but little soluble in the quench salt, which is normally a mixture of potassium nitrate, sodium nitrate and sodium nitrite. The higher the temperature the greater the amount of chlorides that will be held in solution in the nitrates. An excess of chlorides over the amount held in solution drastically reduces the quenching power of the quench salt. Therefore, a well designed furnace must incorporate an effective automatic salt purifying system. To effect this the furnace has two separate chambers; one is the quenching chamber in which the pumps are located; the other is a separating chamber, which is operated at a temperature generally from 30 to 50 deg C lower so that the chlorides are precipitated out of solution. They are then filtered out and the cleaned salts are returned to the quenching chamber.

There are three major forms of isothermal treatment. They are:—

(1) Cyclic annealing in the temperature range 590-680 deg C to produce soft, uniform, machinable structures of pearlite and ferrite.

(2) Austempering, carried out in the range 270-430 deg C and resulting largely in the production of Bainite.

(3) Martempering, occurring in the range 200-270 deg C and resulting in martensite.

Cyclic annealing

This is very little different from conventional annealing except that transformation is made to take place at a constant pre-selected temperature instead of at a slowly decreasing temperature. After the steel has been heated to the temperature required to transform it to austenite, it is cooled as rapidly as possible by quenching in a salt bath operating at a temperature that has been selected to give the desired end result from a study of the time-temperature-transformation characteristics of the steel involved. The work is held at the temperature for the time necessary to effect complete transformation; it may then be cooled in almost any desired manner.

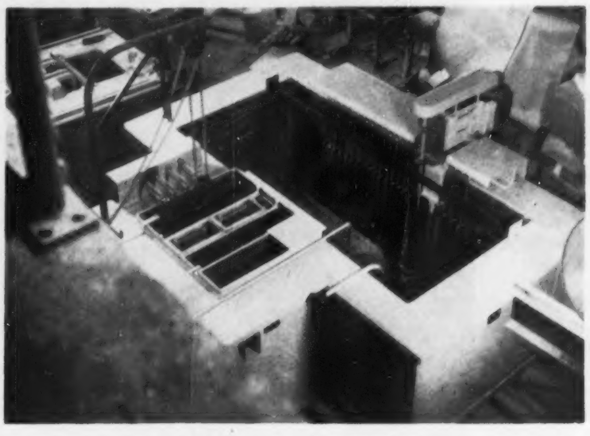
This operation has certain practical limitations. First, the chemistry of the steel should be such as to permit relatively short annealing cycles, generally one hour or less. Secondly, in order to be economical it is generally necessary to employ the annealing operation in conjunction with a forging operation; therefore, it is practically limited to new installations since the annealing furnace must be installed adjacent to the hammer or forging press. Thirdly, it is economical only for production runs of the continuous type. Fourthly, the characteristics of the steel cannot be changed except in a very minor way.

There are, of course, countervailing advantages in suitable applications. A very short annealing cycle is possible, usually less than one hour. Furthermore, a clean surface is generally obtained because there is no air cooling after forging and because a water quench is used after the anneal. In addition, the structure produced is uniform and has superior machining qualities. Finally, under proper conditions, the cost of operation is very low.

Because of the limitations, cyclic annealing installations are not common. Nevertheless, those now in service are outstandingly successful. The biggest installation is that at the Ford Motor Company's forge plant in Canton, Ohio, where four mechanized units are employed, two for annealing ring gears and two for pinion gears. The ring gear installation anneals induction heated forgings of SAE-4028. Forgings are transferred directly from the press to the furnace which is maintained at 645 deg C. The time cycle is 45 minutes. After removal from the furnace, the forgings are flash quenched in hot water for a few seconds. This strips off all salt and removes any slight scale that may be on the work. Neither shot nor sand blasting is needed.

Another installation that has been operated successfully for several years is used in the manufacture of the motor body for a 3·5 in bazooka. This body is produced from tubing of SAE-4140 approximately 2¼ in diameter with ¼ in wall. It is forged at one end to provide the venturi for the propulsive gases. The tube is selectively heated in salt to a temperature of 1175-1200 deg C and is then annealed for 30 minutes at 650 deg C. Hardness after annealing is Rockwell C17-19. Despite the fact that only a portion of the piece is heated and annealed, uniform machining properties are obtained in the whole piece.

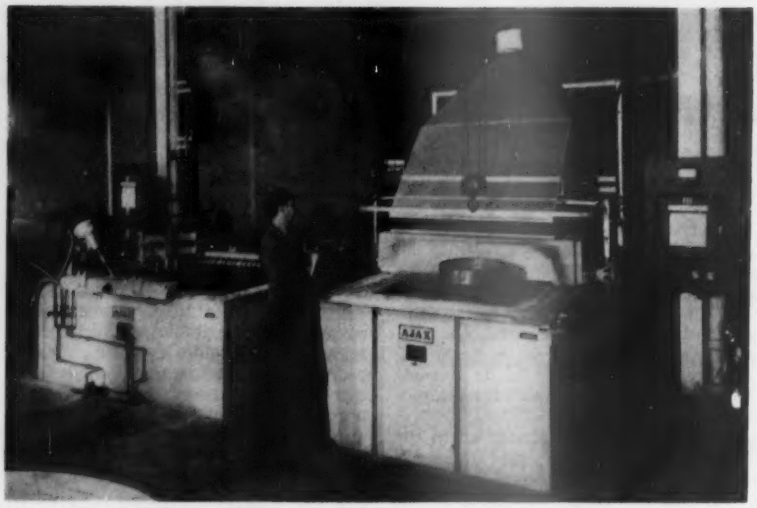
It must be stressed that there is only a limited field of application for cyclic annealing. For example, it is not applicable for a general purpose forging plant. However, where all factors are favourable, it is highly practical.



Isothermal quench bath with centrifugal pump and salt separating chamber

Austempering

The austempering process, probably the earliest of the isothermal



Installation for martempering bearing races

techniques, is carried out to transform austenite into some form of bainite, a condition which has certain characteristics that affect the selection of the equipment and of the process. These are:—

(1) For equivalent hardness, a bainite structure has a lower tensile strength, a lower yield point, but appreciably higher ductility and reduction of area than a tempered martensitic structure.

(2) There will be a smaller volume change than when martensite is produced. Hence a greater control of the size and shape of the piece is possible.

(3) Generally the operating temperature of the quench furnace will be between 300 and 425 deg C.

(4) The maximum section of the piece is usually limited either by the chemistry of the steel or by the fairly high quenching temperature.

Because of these facts, a modification of the conventional austempering treatment has become widely accepted in the U.S.A. and has greatly expanded the field of application. This is known as the three-step treatment, whereas the conventional treatment is two-step. In the three-step treatment, the quenching temperature is not determined by the final hardness desired. On the contrary, a much lower temperature is used to permit much heavier sections to be quenched or for the same section, to allow the use of lower hardenability material. Hard bainite is produced and is subsequently tempered to the desired hardness. With this treatment, better physical properties for most purposes are possible, while retaining equally good control of distortion as that obtained with the conventional austempering treatment.

Generally, austempering offers the following advantages:—

(1) Excellent control of distortion.
(2) Greater toughness at equal hardness.
(3) Better fatigue resistance.
(4) Good appearance.
(5) Lower manufacturing costs.

Austempering is used with excellent results in spring manufacture. The two-step method is generally employed. For example, four large installations are in use at the Delco Remy Division of General Motors Corporation. The first of these was installed to overcome difficulties that were experienced in the production of springs used in signal light indicators. A two-furnace, both salt baths, set-up completely eliminated breakages that had previously been experienced. Other installations are now used for similar articles for ignition and accessory devices. The steel used is generally one of the carbon manganese types of the SAE-1000 series.

The austempering process is also widely used on cast iron cylinder liners for truck engines. For this application the three-step treatment is employed. The average composition of the iron is:—

Carbon	2·95-3·25 per cent
Silicon	0·80-2·20 per cent
Chromium ..	0·20-0·34 per cent
Nickel	0·20-0·40 per cent
Molybdenum ..	0·40-0·60 per cent

Substantially similar treatments are used in several plants. It consists in austenitizing at 830-840 deg C for approximately 12 minutes, quench at 200 deg C for 12 minutes and temper at 220 deg C for 24 minutes. The resulting hardness is in excess of Rockwell C50, but the main object of the treatment is to keep distortion within such limits that all finish machining and grinding can be carried out before heat-treatment, with only a final honing operation to be carried out after hardening.

Brake shoes and sway bars such as those used in the current Ford models are also being austempered. The sway bar is an especially interesting application in that the bar is heated for forming to a temperature in the order of 1100 deg C, hot formed, and then mechanically transferred to an austempering furnace fitted with an internal chain type conveyor. SAE-1085 steel is used, the quench temperature is 270 deg C and the transformation time 10 minutes.

Martempering

Theoretically, martempering calls for quenching at a temperature slightly below the Ms point, holding until stable

Installation for martempering the steel spars of helicopter rotor blades

temperature conditions are established and then air cooling. In practice many applications are carried out with the quench temperature below the Ms point to permit larger sections to be treated. In the tempered condition, the hardness obtained by martempering is equal to that produced by conventional quench and temper practice; as quenched and air cooled but before tempering it is lower than oil quenched hardness because of partial tempering. The quench requires effective and controllable agitation of the salt. The main objects of the treatment are to control the distortion created by hardening and to provide a service performance at least equal, and often superior, to that of the conventional treatment. In general, steels of higher alloy content are used for martempering and much greater hardness is obtained than in austempering. There is a considerable field for this process.

Combined carburizing and martempering

Combined carburizing and martempering applications can be divided into two types. In the first the carburizing may be done by any selected method, pack, gas or liquid; the work is then air cooled to room temperature and subsequently re-heated and martempered. This is merely martempering in the manner previously described. This method is employed for gears of various types, especially highly stressed gears used in aircraft turbine-type engines. Approximately two-thirds of the gears used in one well-known engine are martempered in this manner with distortion kept within specified tolerances, so that finishing problems are greatly eased.

At present, because of handling problems, applications of the second type are largely confined to liquid carburizing. As it is not possible to quench direct from cyanide salts into nitrate salts, an additional furnace is used between the carburizing and martempering units. Its operating temperature is usually lower than that of the carburizing furnace.

Direct martempering after carburizing is employed on heavy duty truck transmission gears produced by the Wisconsin Axle Division of Timken-Detroit Axle Co. The complete treatment is: —

Carburize at 925 deg C for 4 hours.
Neutral wash at 815 deg C for 1½ minutes.
Quench at 340 deg C for 5 minutes.
Air cool for 30 minutes.
Stress relieve at 180 deg C for 30 minutes.

We are indebted to Electric Resistance Furnace Co. Ltd., Netherby, 161, Queens Road, Weybridge, Surrey, for the information and the illustrations contained in these notes.

M.I.R.A. REPORTS

Recent Releases for General Circulation

SEVERAL reports on work carried out by The Motor Industry Research Association, Lindley, nr. Nuneaton, Warwickshire, have been released for general circulation. Summaries of several of the reports are appended. Full copies can be obtained from M.I.R.A. at 10s. each.

Experimental stress analysis of a small saloon car of unitary construction. Report 1951/12 describes the investigations to determine the stresses due to static loading. The tests were directed at finding the stresses due to all components of static load applied to the structure, namely, the body structure itself of 800 lb load, the engine and gearbox mounting load of 125 lb and a passenger and luggage load of 970 lb. A torsional load of 2300 lb/ft was applied by removing the support from under one rear spring of the fully laden vehicle. The stiffening effect of the front wings and doors under torsional loading was also investigated.

A large number of wire resistance gauges was used to obtain comprehensive plots of stress variation along and around members such as the underframe section, the body pillars, the door jambs and sills, and the roof. The results show that the stresses due to the torsional load are generally considerably greater than those due to the direct load, and that the most highly-stressed part of the structure is the lower end of the windscreen pillar.

Report 1952/2 describes the experimental stress analysis for the same small saloon car under dynamic loading conditions. In this case the tests were directed at determining the general level and distribution of stress in the body structure under conditions of bumping, cornering and braking. The results are compared with those previously recorded for static loading (Report 1951/12).

The influence of the crankshaft material on the bending fatigue strength of cast crankshafts. There are three reports on this subject. The first, Report 1950/2, makes comparisons of the bending fatigue strengths of cast crankshafts made from the seven following materials: a low-alloy inoculated iron, a chrome-molybdenum alloy iron, a pearlitic malleable iron, "graphitic cast steel" and three "acicular" irons.

Investigation on crankshafts made from four cast steels are described in Report 1951/14. Briefly, it was found the bending fatigue strengths of a crankshaft made from four cast alloy steels, with tensile strengths ranging from 65 to 85 ton/in^2 were about 40 per cent greater than those for the high duty cast irons dealt with in Report 1950/2.

Report 1952/1 deals with bending fatigue tests carried out on two batches of crankshafts made from cerium-treated nodular graphite irons and two batches made from magnesium-treated nodular graphite irons. Cerium-treated nodular irons, with tensile strengths of 28 and 31 ton/in^2, gave bending fatigue strengths similar to those obtained with flake graphite irons. Magnesium-treated nodular irons gave only a small improvement of crankshaft fatigue strength although the tensile strengths were in the order of 50 ton/in^2. The investigations described in these three reports show only a small increase of bending fatigue strength accompanying an increase in the tensile strength of the crankshaft material. The advantage of this small increase may be more than offset by the greater difficulties associated with the casting of higher strength materials.

The influence of shot peening and cold rolling on the bending fatigue strength of cast crankshafts. This subject is discussed in Report 1952/3. Both reversed bending tests and one-way bending tests were employed, since crankshafts in service may be subjected to a loading intermediate between these conditions.

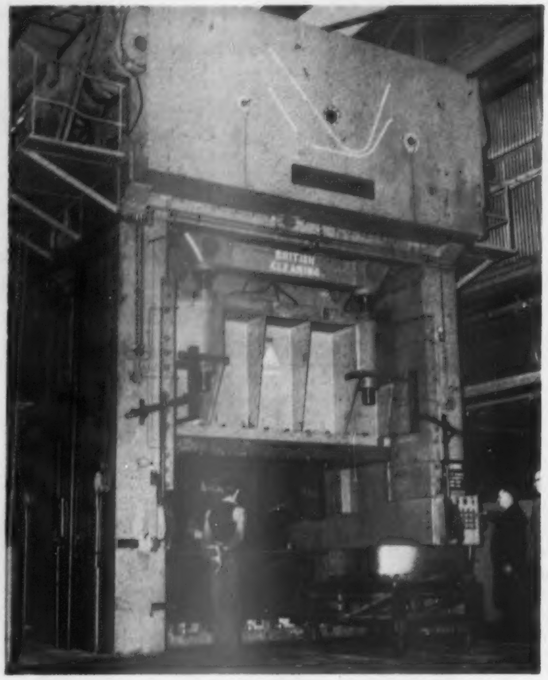
Preliminary tests on cast bars showed that under reversed loading, peening increased the strength by 15 to 30 per cent. Under one-way loading, the improvement was in the order of 35 per cent, and if the peening was followed by polishing, as would be necessary with production crankshafts, an improvement in the order of 45-50 per cent was obtained. Peened and polished crankshaft specimens gave an improvement of about 50 per cent under one-way loading.

Even better results were obtained by using steel balls under heavy load to cold work the fillets of the crankshaft. On crankshafts so treated the improvement under reversed stress was about 60 per cent. Under one-way loading the improvement was as much as 80 per cent. Fillets produced in this way are clearly superior to fillets finished by conventional methods since, apart from the beneficial cold working effect, they are smooth, truly circular, and of closely controlled radius.

It is pointed out that the rolling operation usually produces a small "build up" of metal at the junction of the fillet and the journal surface. This is not important if the journal is to be ground after the fillets are rolled. Alternatively, the ridge of metal can be removed quite easily by a light polishing operation.

HEAVY PRESSWORK

British Clearing 1700-ton Capacity Triple-action Press



British Clearing 1700-ton Hiprodraw triple-action press

AN important addition to the range of British Clearing Hiprodraw presses built by Vickers-Armstrongs Ltd., Elswick Works, Newcastle-on-Tyne, to the general design of the Clearing Machine Corporation, Chicago, U.S.A., is shown in the accompanying illustration. It has recently been installed at the works of Vauxhall Motors Ltd., Luton, Beds. Hiprodraw presses incorporate design features that make possible higher production rates than can be obtained from a conventional drawing press, and this without any increase in the drawing speed.

The press mechanism incorporates an ingenious linkage so designed that the stroke cycle has a rapid closing speed, a reduced drawing speed and quick reversal of both slides. The inner slide and the blank-holder approach the work at the same speed. When the blank-holder reaches its dwell position, the inner slide immediately starts the drawing stroke at a greatly reduced rate of speed. On the completion of the draw there is quick reversal of both slides. It will be appreciated that the action of the linkage controlling both inner and outer slides operates the press at a shorter stroke cycle than is feasible with a conventional press. It also allows a very slow drawing speed for difficult operations without any marked effect on the output rate.

For two reasons the Hiprodraw press shown in the illustration is of particular interest. First, it is the largest press of this type to have been built in this country. Secondly, it is a triple action machine. In effect this type of machine can be regarded as two presses with a common bed. That is, there is first an upper double-action down-stroking press, and second a lower single-action up-stroking press attached to the underside of the bed. To increase still further the versatility of this press, two pneumatic cushions are also included in the lower slide.

It is possible to use the press for either double- or triple-action work. When the press is used for triple-action work, the upper mechanism comes into action first and when it has completed the draw stroke an automatic control cuts out the upper action and causes the slide to dwell at the bottom of the stroke. At the same time the lower action is automatically cut-in to carry out its operation. When the stroke cycle of the lower action is completed, the press automatically returns to the rest position in preparation for the next stroke. By pre-selection the lower action can be made to remain idle to allow the press to be used for double-action work with or without the use of the pneumatic cushions. In double-action there is no dwell of the inner slide at the bottom of the stroke.

Both the upper and lower actions are fitted with the most recent design of pneumatically operated clutch and brake, the Tornadyne. This feature further increases the handling capacity of the press by virtue of its greatly increased inertia in comparison with conventional types. This is particularly advantageous in triple-action when the upper action clutch and brake are engaged twice for each press stroke.

The drive for the upper action is by a 125 h.p. motor and to the lower action by a 40 h.p. motor. Both motors are of the high-torque, high-slip type. They transmit the power through vee-belts to the flywheels, which weigh 5 and 2½ tons respectively. Upper and lower slide adjustment is effected through 7½ h.p. motors. Various pre-selected automatic control cycles are available. The frame is all steel welded and the principal dimensions are: inner slide 800 tons capacity; blankholder 500 tons capacity; lower slide 400 tons capacity; area of bed 80 in × 144 in; effective draw stroke, inner slide 13 in, lower slide 10 in. Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Rd., London, N.W.2, are sole agents for these presses.

PLASTIC TRAILERS

BECAUSE of their light weight, durability and non-corrosive qualities, reinforced plastics are being used to an increasing extent for commercial trailers in the United States of America. One of the more interesting recent developments is a 4,000 gallons capacity single-piece milk truck made of polyester resins.

A process known as the Marco method was used. This process permits the introduction of resins between moulds by vacuum or pressure, or a combination of both. It allowed the tank to be produced in one piece and in addition, eliminated porosity. A special frame provides for air suspension.

Lay-up of this new polyester resin tank included, besides Fiberglas cloth and mat, a two-inch ply of balsa wood, which in combination with the plastic, provides excellent insulation. There was also a thin inner tank of stainless steel. After preparation, Marco resins were drawn into the wooden mould. Following a short curing period, the tank was lifted from the mould in one piece.

Supporting skirts running the full length of each side, as well as wiring for lights, were moulded in place as integral parts of the tank. Silvery paint, applied to the mould before application of the resin, adhered to the tank and thus eliminated the need for a finishing operation. The Marco method was developed by the Marco Products Department of the Celanese Corporation.

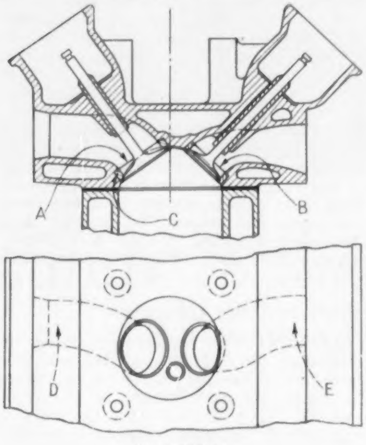
CURRENT PATENTS

A Review of Recent Automobile Specifications

O.H.V. Cylinder head

IN a cylinder head in which the combustion space is domed or of penthouse shape, it is usual for the inlet and exhaust valves to be inclined at equal and opposite angles, commonly of 45 deg, to the cylinder axis. Effective combustion depends largely on the extent and direction of the swirl imparted to the incoming charge by the inlet port. The disposition of the exhaust port also has an influence since it determines the completeness of the flow of combustion gases from the cylinder and the effectiveness of the gas inertia action on the new charge during the valve overlap period.

According to this invention the valves are arranged at unequal angles, that for the inlet valve being the smaller. It has been found that optimum swirl is



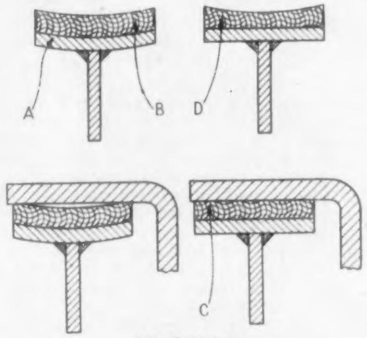
No. 700364

obtained when the inlet port A is inclined at 35 deg, and in conjunction with this a suitable angle for the exhaust port B is 43 deg. As usual, the port areas are unequal, the ratio of inlet to exhaust being about 8:7. The angular separation between the adjacent edges of the two ports is about 15 deg on the combustion space contour, which gives adequate room for inserted seatings C for both valves.

Inlet and exhaust passages are each of an approximate venturi shape, with a waist at D and E respectively. In plan each is curved and its axis, at its point of intersection with the plane of the port, is oblique to a radius of the cylinder which meets it in that plane. *Patent No.* 700364. *Henry Weslake.*

Fabricated brake shoe

A TENDENCY in recent years has been to use tyres of larger cross-section upon smaller wheels and consequently brake drums of smaller diameter have been fitted with wider shoes to secure the requisite braking affect. Since it has also become common practice to fabricate shoes from two sheet-metal parts, the head plate carrying the lining is likely to lack the rigidity of the earlier cast or



No. 700534

stamped component. As a result of deflection under load the lining tends to wear at the centre, where the head plate is supported by the web.

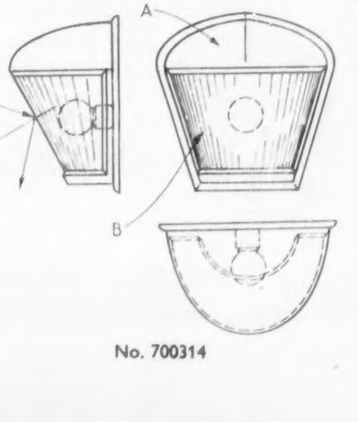
To extend the useful working life of the lining and to improve the braking effect, this invention proposes that the head plate A is of transversely concave form and fitted with a lining B of uniform thickness by any conventional means. A light application of the brake brings only the marginal edges of the lining into contact with the drum but as the load is increased the concavity of the head plate is reduced. At maximum loading the head plate is deflected to a transversely flat form and the lining makes full-width contact, as at C. When the loading is removed the head plate and the lining will reassume their transversely concave form.

In an alternative construction a preformed lining D having a transversely concave working surface is secured to a transversely flat head plate to achieve the same effect. *Patent No.* 700534. *Austin Motor Co. Ltd.*

Flashing direction lamp

SOME criticism has been advanced against the flashing-type direction indicator since, under certain conditions, the sun's rays or the light from the headlamp of an approaching vehicle may render the signal unrecognizable or be reflected and mistaken for a signal. The invention aims to obviate this defect.

In an opaque housing A of sheet metal

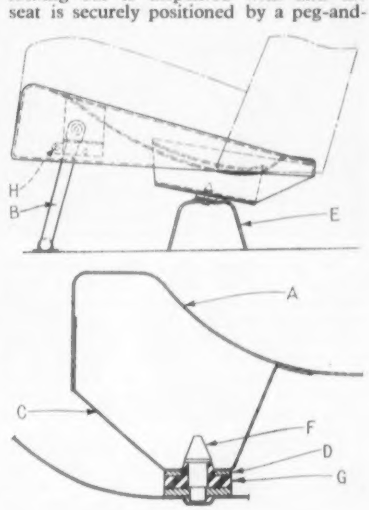


No. 700314

or plastics is fitted a transparent pane B of coloured glass or synthetic material. The pane is bowed to the form of part of an inverted conical shell and thus the outer face is inclined towards the ground. Although the signal light is visible over a wide angular range, incident light rays from an external source are reflected downwards, as indicated, and will not confuse either vehicle drivers or other road users. *Patent No.* 700314. *Daimler-Benz A.G. (Germany).*

Adjustable seat

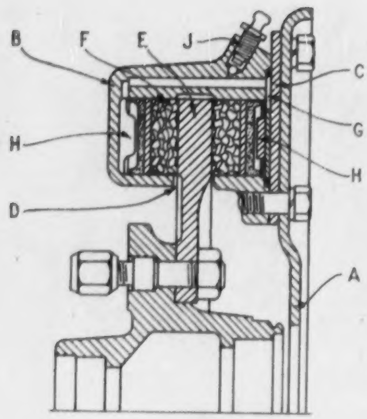
IN an adjustable seat of the pivoting front leg type, the usual notched interlocking bar is dispensed with and the seat is securely positioned by a peg-and-



No. 700263

hole arrangement on the rear support. The seat pan A is pivotally attached near its forward edge to the upstanding legs of a U-shaped tubular member B, which in turn is pivotally secured to the vehicle floor. Trough-like members C, welded to each side of the pan near the rear, are furnished at the base with a reinforcing plate D and formed with a series of spaced holes.

A transverse inverted trough E, formed integrally with the sheet-metal floor, serves as the rear support. To the top of this transverse support are rigidly secured two tapered metal pegs F, spaced to engage selected pairs of holes in the seat members. The stem of each peg is shouldered by a rubber pad G to provide a rattle-free seating. To adjust the position it is necessary merely to lift the seat, move it bodily fore or aft and lower again on appropriate holes. Laterally-projecting stops H limit movement of the front legs, but alternative holes may be provided in the floor for changing the position of the anchor pivots to vary the amount of leg room. In the absence of an integral tranverse member E, the pegs may be supported on brackets or extended trough members C may engage pegs secured directly to the floor. *Patent No* 700263. *Morris Motors Ltd.*



No. 700644

Disc brake

IN this brake one or more pairs of opposed friction pads are carried in a stationary caliper block and are urged by fluid pressure into engagement with opposite faces of a disc associated with the vehicle wheel. The anchor plate A, taking the braking torque, is a steel pressing of sector shape stiffened by a peripheral flange and is bolted to the axle casing. To the flat outer surface of the anchor plate is bolted the kidney-shaped caliper block B; a reinforcing plate C may be interposed.

In the caliper block the appropriate number of blind bores, machined from the face that abuts the anchor plate, are intersected by a slot D which receives the outer portion of the brake disc E secured to the wheel hub. Cylindrical blocks F of friction material are slidably mounted in the bores on each side of the disc, and each is backed by a piston provided with a cup-type seal.

By means of undercut recesses and drillings all the bores are in open communication with the recess G from which a connection is taken, through either the block or the anchor plate, to the braking system master cylinder. Make-up elements H may be fitted in the ends of the bores to reduce the volume of pressure fluid and so avoid loss of pedal travel due to compression during operation. A bleed valve J is arranged at the highest point of the flow passages. The axial length of a friction block is less than the width of slot D so that it can be inserted through the slot and into its bore before the block is fitted over the disc.

In a modified construction, block B is made in two parts, each having short blind bores. The plane of division is at right angles to the axis of the disc and the parts are welded or copper-brazed together. *Patent No.* 700644. *Girling, Ltd.*

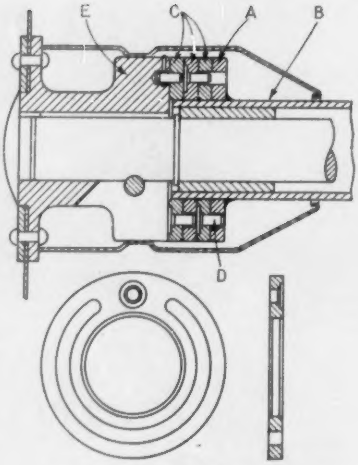
Self-lubricating piston rings

SELF-LUBRICATING bushes and bearing brasses are made of a sinter alloy of iron, copper, and graphite powders. The graphite, however, produces a certain brittleness in the alloy, thus rendering it useless for applications where a considerable degree of elasticity is required. It is stated that an addition of from 0·3 to 0·8 per cent beryllium to the mixture will overcome this difficulty. Since articles produced by the powder metallurgy technique are consolidated by pressing while at red heat, it is not possible to alloy in the usual manner by mixing at or above melting point. It has been found, however, that even at this temperature a certain pressure will ensure an adequate diffusion of the beryllium into the other metals, principally the copper.

To secure worthwhile advantages the constituent proportions of the sinter alloy should be kept within the percentage ranges of 50 to 60 Fe, 35 to 45 Cu, 0·3 to 0·8 Be and 4 to 8 graphite. An especially favourable percentage composition is 54 Fe, 39 Cu, 0·4 Be and 6 graphite. The method consists of heating the mixture of metal powders and graphite to red heat and cooling it under pressure. The elastic properties of the sinter alloy can be increased by hammering. A piston ring treated in this manner can be opened sufficiently to pass over the piston body and into its groove and still retain the necessary resilience to serve as a packing with respect to the cylinder bore. *Patent No.* 700256. *Aktiengesellschaft fur Bergbau-und Huttenbedarf (Germany).*

Limiting angular movement

TO limit relative angular movement between two components, a projecting pin on one member may be engaged in an arcuate slot in the other. When the permitted movement approaches or exceeds 360 deg a series of slotted rings, each having a rigidly mounted pin working in the slot of an adjacent ring, may be employed.



No. 700635

A practical application of the invention is the provision of positive limits for the steering mechanism of motor vehicles. In the example shown, a ring A of hardened steel is welded or brazed to the steering column B and three freely positioned intermediate rings C are fitted. Each of these four rings is formed with an arcuate slot subtending an angle of about 300 deg and each of the three intermediate rings is additionally furnished with a pin D. A pin secured in the hub E of the steering wheel engages the slot in the uppermost ring. To reduce friction to a minimum the rings are ground flat on each face and are lubricated. *Patent No.* 700635. *Guy Motors Ltd., W. T. Gwilliam and H. Evans.*

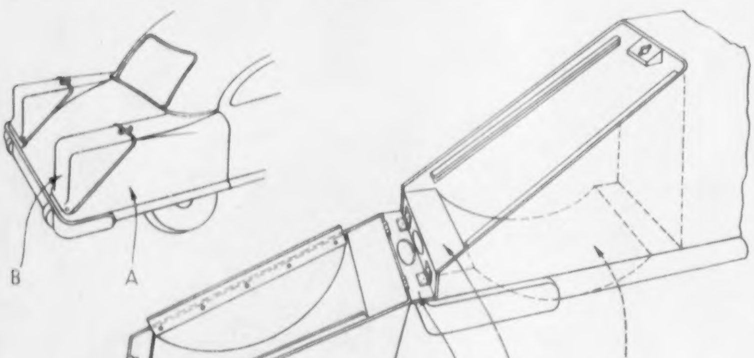
Body tail end treatment

EXPLOITING the current trend to extend the rear wings as fins, it is proposed to utilize the extensions as lockers to house the spare wheel, or a pair of wheels. It is claimed that not only is the boot left clear for luggage but removal or replacement of the spare wheel is facilitated. Location of the fuel tank or tanks is also more easily arranged.

The rear wheel enclosures are prolonged rearwardly to form on each side of the boot a separate compartment A, closed by a lid B hinged at its lower rear extremity. When opened, the rear wall of the lid abuts against the bumper or bumper overrider with a suitable rubber stop interposed. Rubber weather-sealing strips are, of course, provided at the diagonal joint face. At least one compartment is fitted with an arcuate base C to receive a wheel and a similar arcuate partition D is provided in the lid to contact the tyre when the lid is closed over a wheel. Preferably this partition is sprung to constrain the wheel firmly when in position.

In the lowered position the lid may be arranged to serve as a ramp over which the wheel may be rolled when being removed or replaced. By attaching the lid to a hinged distance piece E an effective closure, it is claimed, is obtained. At the rear of the compartment the boxed construction at F can be used to house rear and stop lights or, alternatively, to carry small tools.

Modified constructions include hinging the lid on the outer diagonal joint, hinging on an outer vertical joint, and fabricating the lids in a unit with a top-hinged boot lid. *Patent No.* 700690. *W. R. L. Torrance (Canada).*



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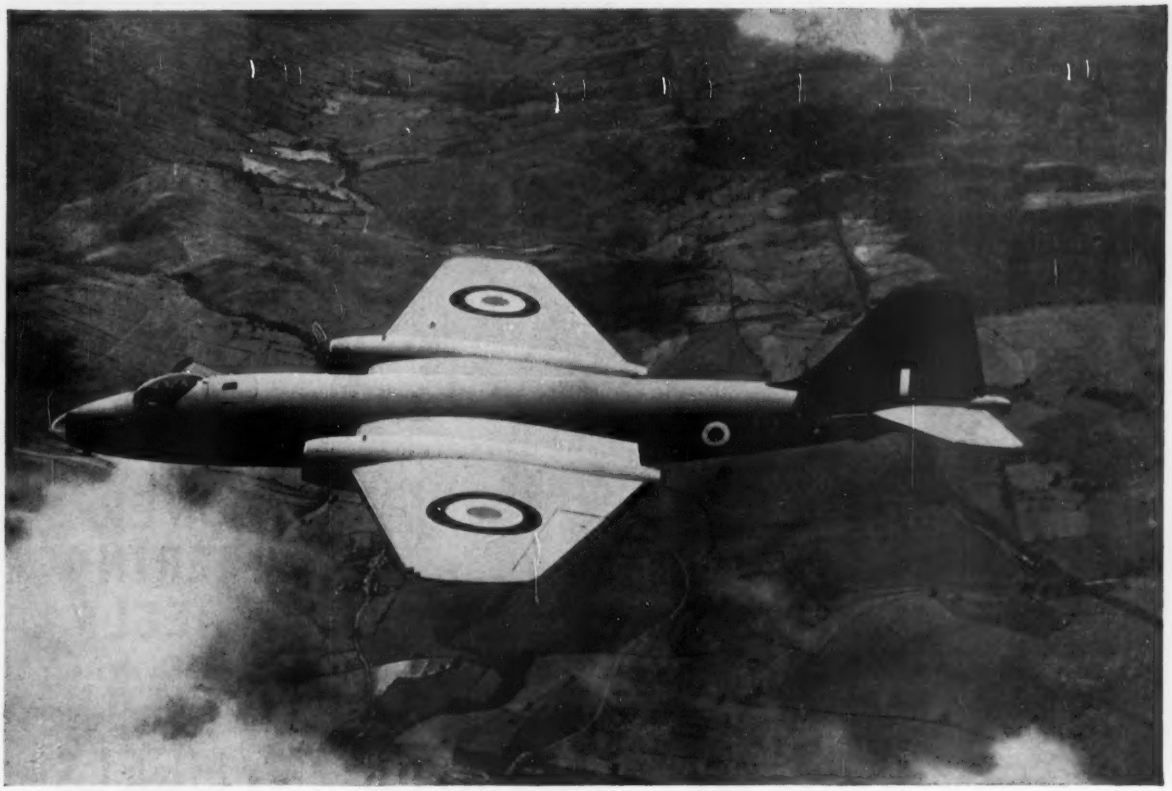

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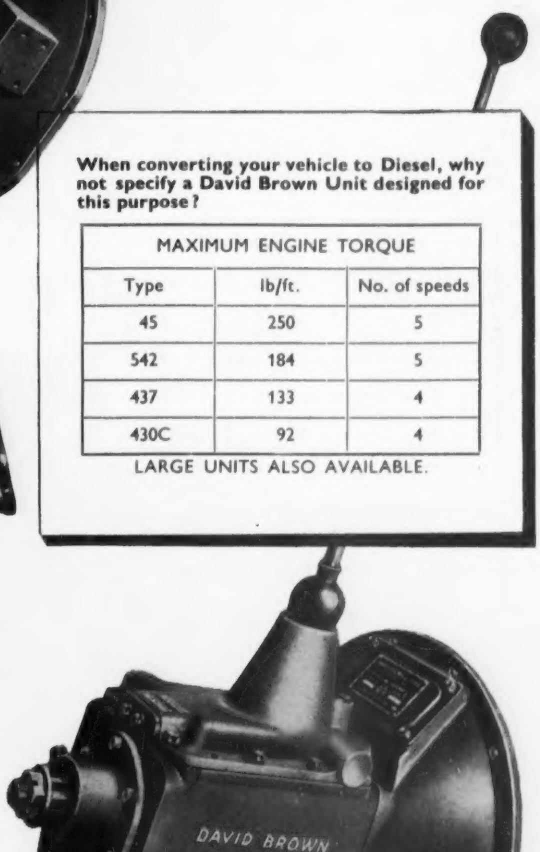

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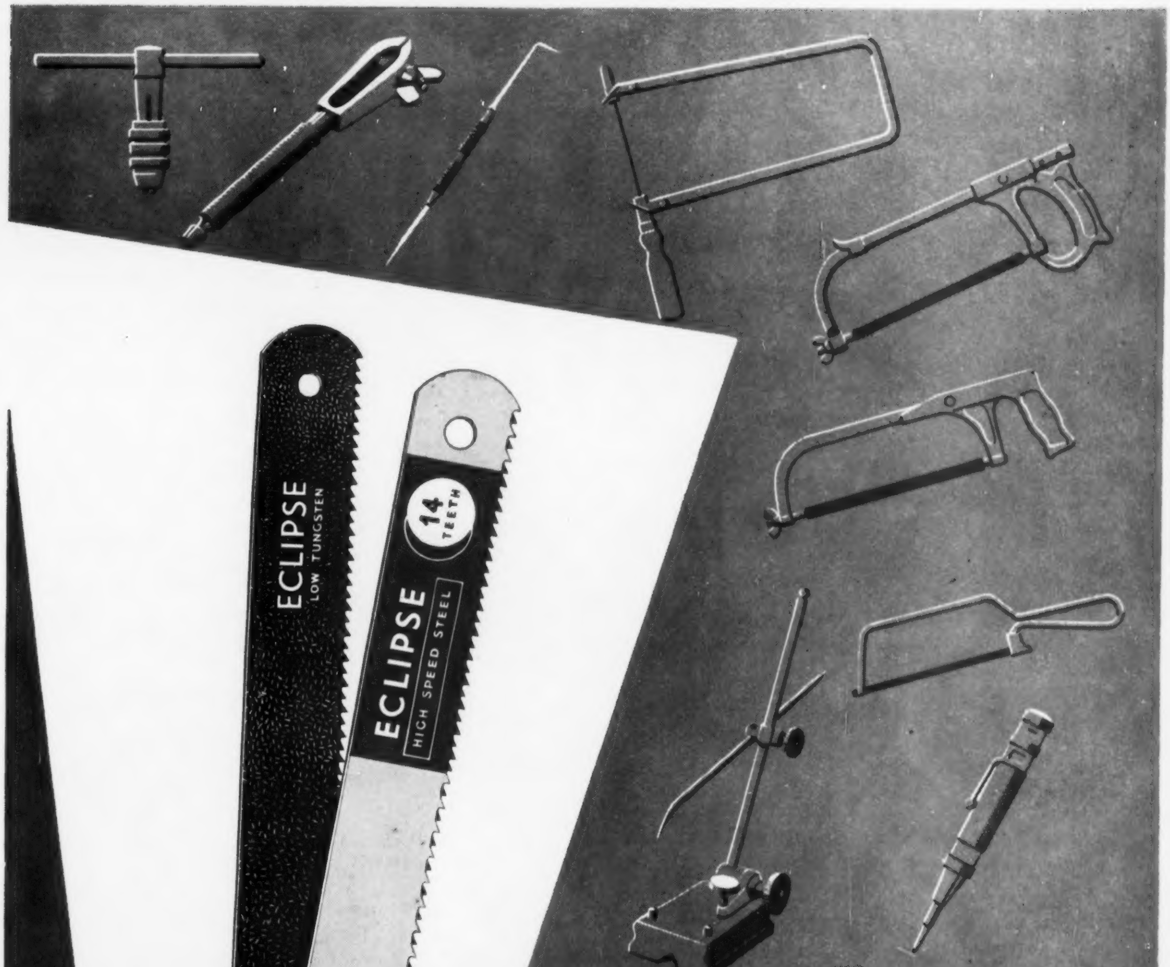
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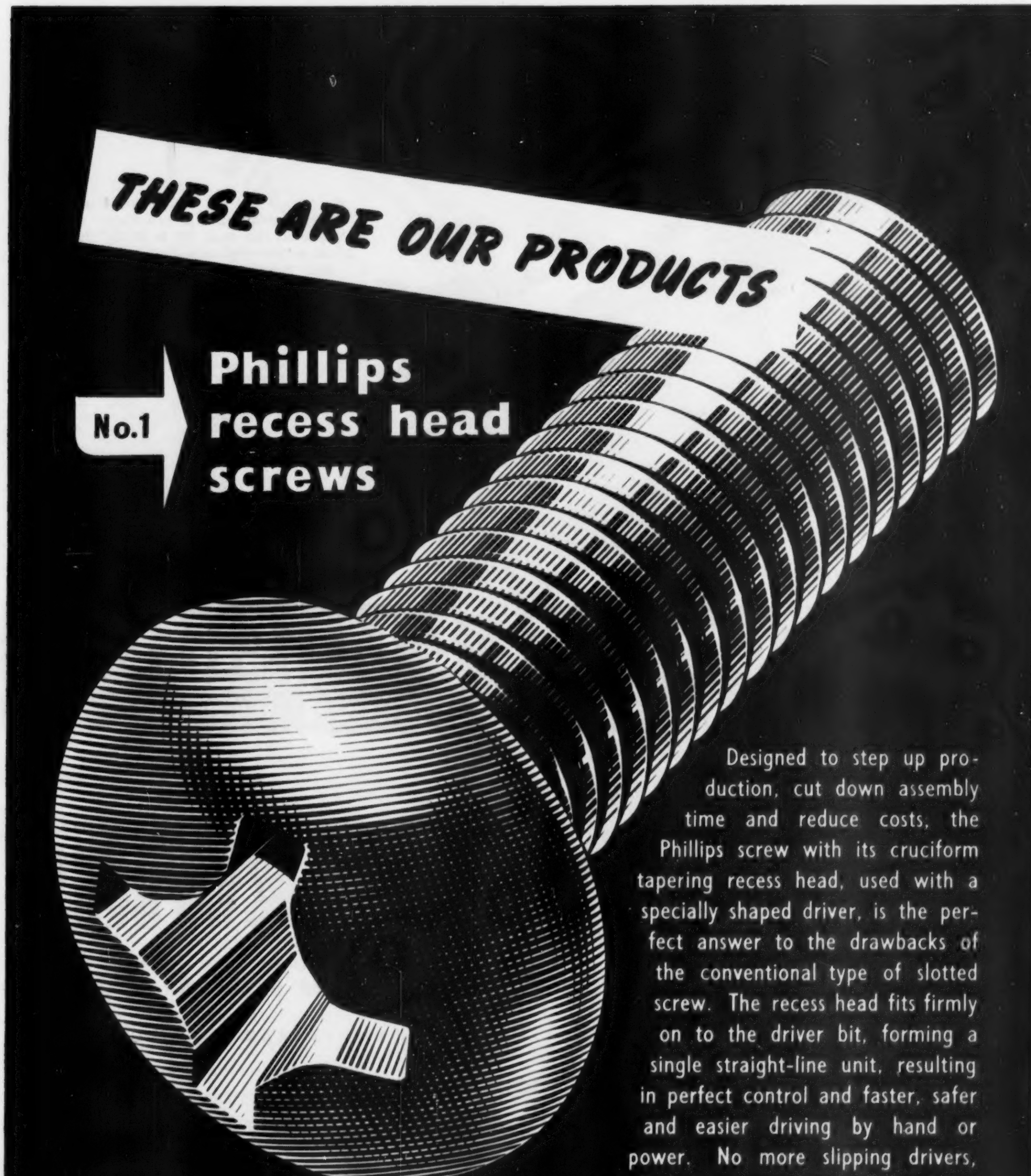
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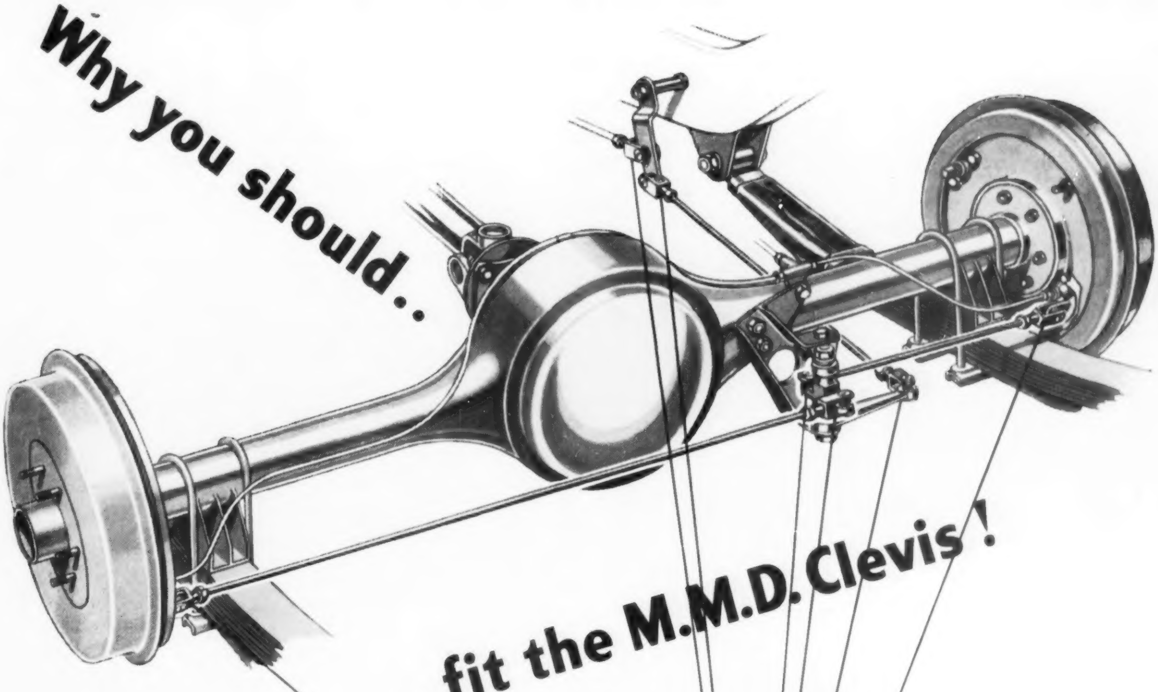

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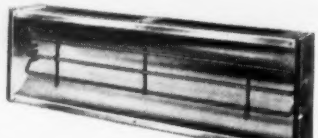

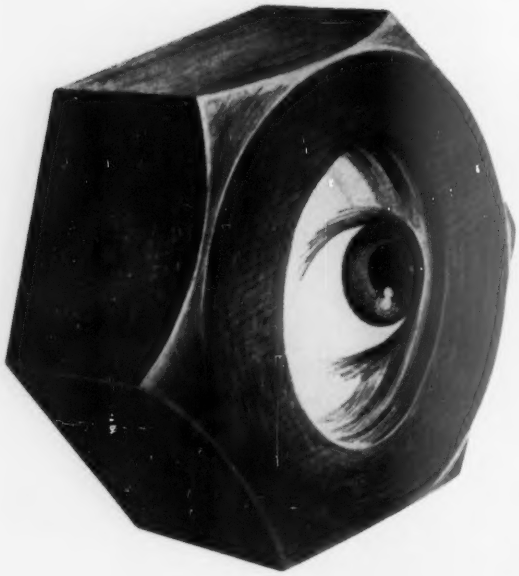

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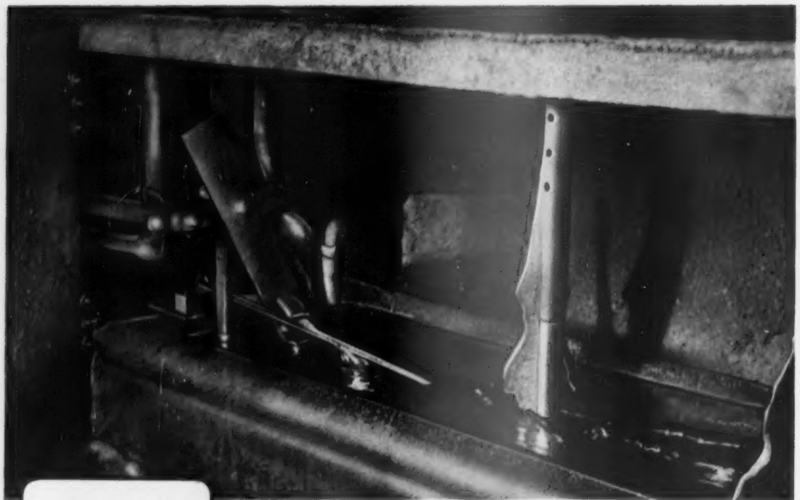

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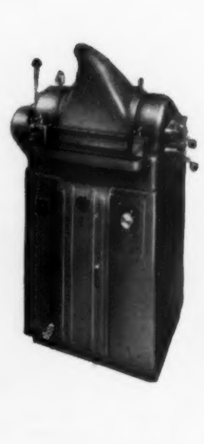

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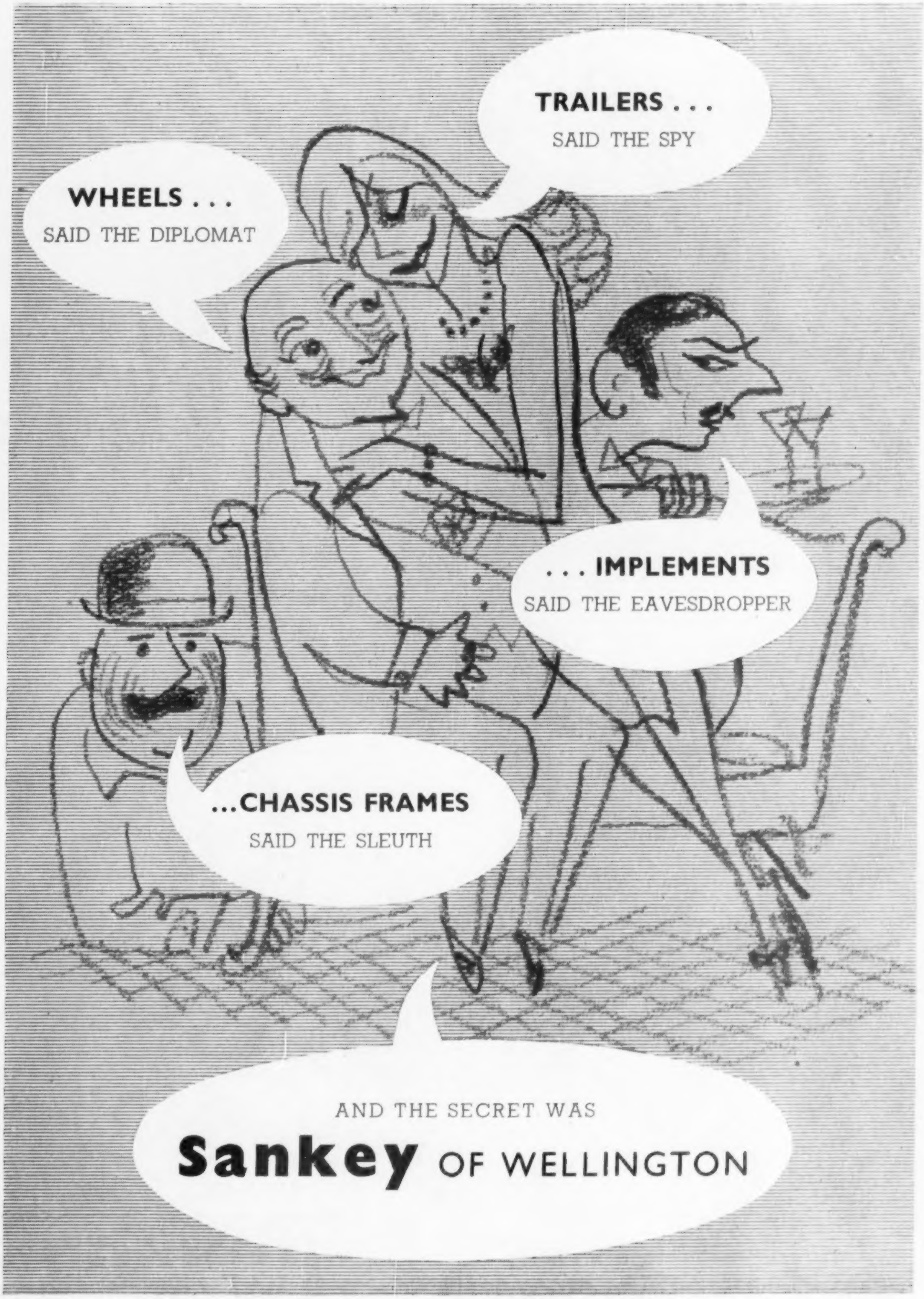

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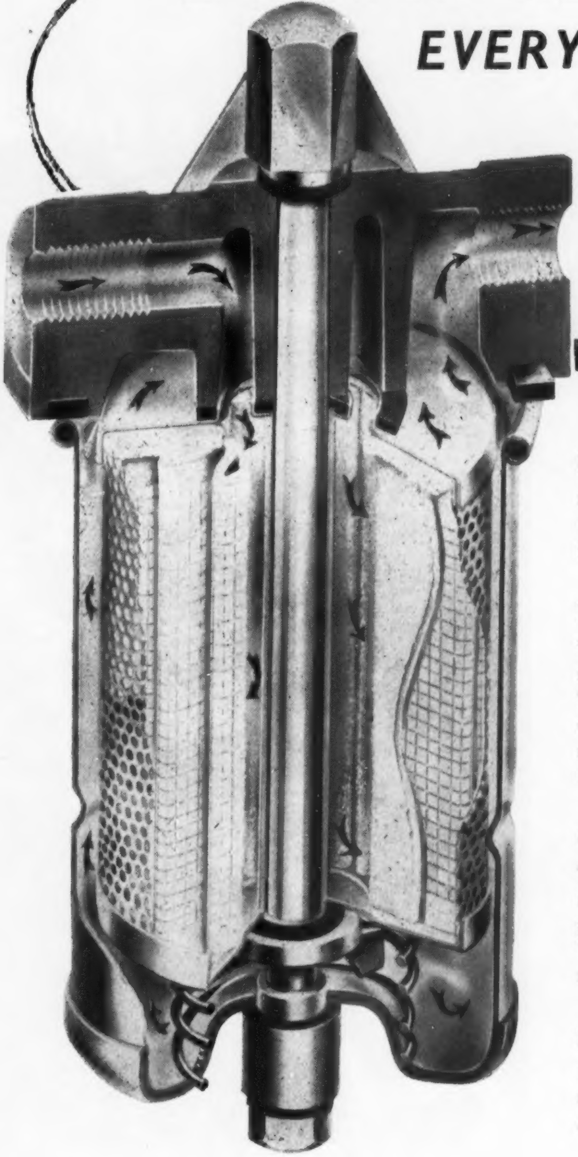

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Mr. J. Jennings, responsible for the maintenance and servicing of the 'Post and Mail' fleet of more than 100 vans, is delighted with results obtained from Duaflex rings. "Newspaper delivery vans are notoriously hard worked" he says "but Duaflex have stood up wonderfully to continuous stop-start driving and show a great saving in maintenance time and costs".

26 Vans Average 59,400 miles without re-bores

Since April 1948, twenty-six vans have been fitted with Duaflex rings and between them have completed 1,545,000 miles without a re-bore. One has exceeded 100,000 miles and five are close to the 90,000 mark. And that means a real saving.

This has been achieved with 48 sets of Duaflex rings — a considerable saving over the cost of re-bores which would normally have been required, quite apart from the time saved on servicing operations.

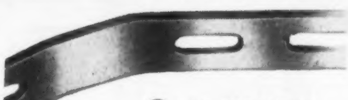
In the notoriously hard driving conditions imposed on newspaper vans these rings have proved themselves a vital factor in the economy of fleet operations.

HOW DUAFLEX RINGS WORK

The principle of Duaflex rings is unique. They are designed to expand in two directions; vertically, to seal the rings in their grooves; and outwardly to press against the cylinder bore. In this way an oil and gas-tight seal is maintained between piston and cylinder wall.

SECTION THROUGH RING

① THE VERTICAL SEALING SPRING



② THE EXPANDER

Three Exclusive Features

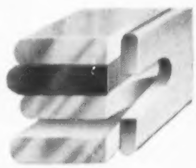
The vertical sealing spring (1) seals the ring in its groove. The "Expander" (2) maintains an even outward pressure ensuring perfect contact with cylinder walls however worn or distorted the bore may have become. And the rails (3) are designed to 'wipe' oil from the cylinder walls and avoid scraping and consequent wear.

Chrome plated for longer life

Further protection for cylinders and rings is provided by chrome plating. The wear-resisting qualities of chromium plate and its resistance to corrosion means longer life for both cylinder bores and the rings themselves.

Special rings for chrome plated bores

Like all chrome plated rings the new Duaflex is not suitable for use in chrome plated bores. A chromium plated bore will not retain oil to the same extent as a cast iron bore, and this factor, coupled with the very efficient wiping action of a Duaflex ring, may lead to dryness in the cylinder, with the possibility of seizure. So a special Duaflex Ring — "The Gold Line" has been evolved to bring all the advantages of Duaflex rings to chrome plated bores. The "Gold Line" Duaflex may be used with great advantage and perfect safety in engines using chrome plated liners. As the illustration shows, in the "Gold Line" version one of the rails is of bronze and projects .002″ beyond the others so that it initially smears the bore with bronze. This coating of bronze assists the lubrication necessary for the critical period of "bedding-in".



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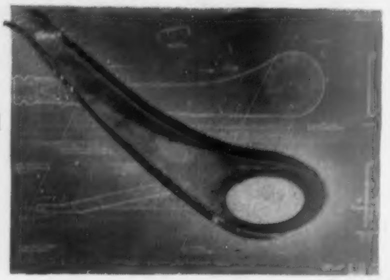
High Strength to Weight Ratio



When a relatively low weight factor must go hand in hand with a high degree of strength and rigidity a decision as to the means by which a component is to be manufactured should be withheld until it has been ascertained whether it is practicable to make it as a pressing, and what would be the cost.

Put simply, *pressing* is a manufacturing science by means of which steel sheets of comparatively modest thickness can be formed and shaped into component parts that will support what often appear to be, at first sight, loadings in excess of the physical characteristics of the material. The metal is manipulated in modern power presses by means of expertly contrived dies. A pressing is originated from a 'design study' which aims at a shape and arrangement which resolves the forces acting upon the component through its planes of maximum resistance.

Our Works are equipped to produce** cold **pressings using steel sheet up to $\frac{3}{16}$" thickness, and** hot **pressings using material up to $\frac{3}{4}$" thickness. It is part of our service to undertake 'design study' on behalf of any Company interested in pressings so that the actual design of a part may from the beginning closely conform to the design requirements of the manufacturing process. One, or a short series of pressing operations, depending upon the design, may be necessary in order to produce a particular part.

This pressing illustrates simply, albeit effectively, the principle that is applied in this process of manufacture. It is the end wall of a rail container. In its basic form the sheet of metal with which each end is formed would be insufficiently rigid, but certain contours are introduced by *pressing* and these impart to the sheet of metal the required degree of rigidity and strength. *The press used for this pressing is believed to be the largest of its kind in Europe. Members up to 30 ft. long can be* **cold pressed.**

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JOHN THOMPSON GROUP — JOHN THOMPSON MOTOR PRESSINGS LIMITED

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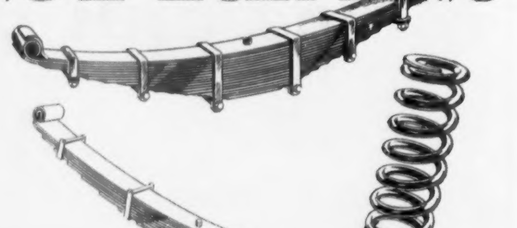
SPRINGS
for the motor industry



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On the Record

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to safeguard their products against corrosion and to protect a fine finish against creeping failure caused through accidental damage.

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Incidentally, if you are not in regular receipt of "The Bonderizer" (representative issues of which are illustrated) we should be happy to add your name to our Mailing List. We are confident you will find its features of interest.

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Hobson *perfect* window regulators

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Duties of liaison with design, selling, production, finance, and other divisions on all matters affecting current production and modifications thereto. Good co-ordinating ability.

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Men with sound practical knowledge of styling and with knowledge of the subject from all angles, leading to the ability to evaluate current and future trends.

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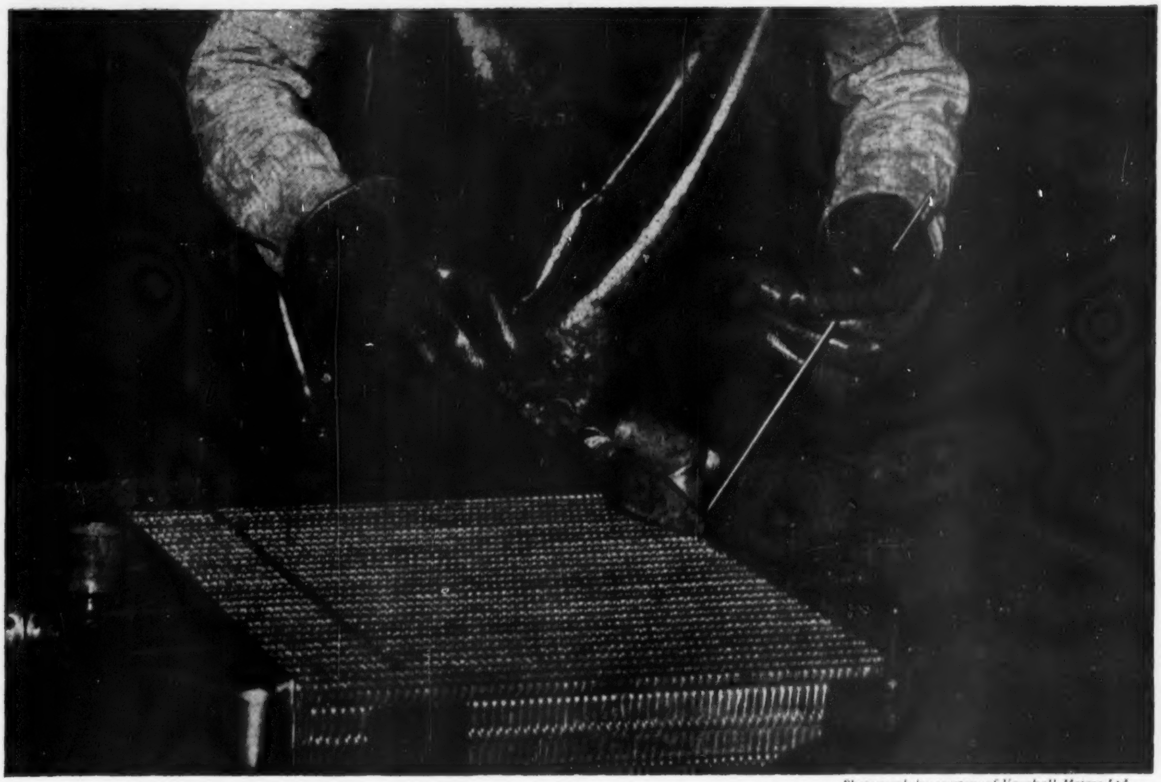

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SB1

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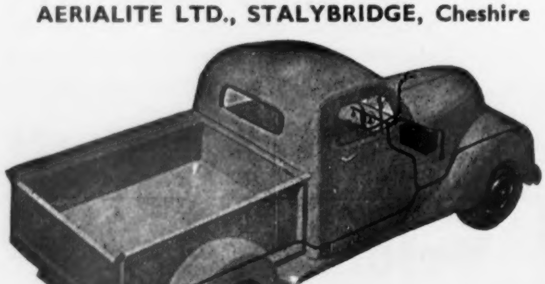

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Once upon a time, a hare and a tortoise had a race. The hare got so far in front that it lay down to rest, fell asleep, and, whilst asleep, was passed by the tortoise who won the race. The moral, as we see it, is that the slowest may be the quickest in the long run.

CLAYTON Cranes and Hoists with MICRO-SPEED UNITS combine the speed range of the tortoise and the hare; dead-slow movement for Foundries, Machine Assembly and such like on hoisting lowering and travel motions with the normal fast speed instantly available at the press of a button. May we send you details.

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are *ingeniously* designed to CUT TOOLING COSTS

Simplicity is the keynote of this new and ingenious design by Plessey.

The Interchangeable Press Tool Set is so designed as to enable the top and bottom bolsters to remain in the press, with the consequent elimination of tool room setting.

Tool changing "on the job" by a setter/operator is a matter of a few minutes, only the die set being changed when a new tool is inserted.

The Press Tool Set is supplied with all plates pre-machined, accurately ground and pre-assembled, thus saving hours of preparatory work in the tool room. Bolster sets are available in three sizes to accommodate 9 sizes of die from 3" x 3" to 5" x 6".

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PT3

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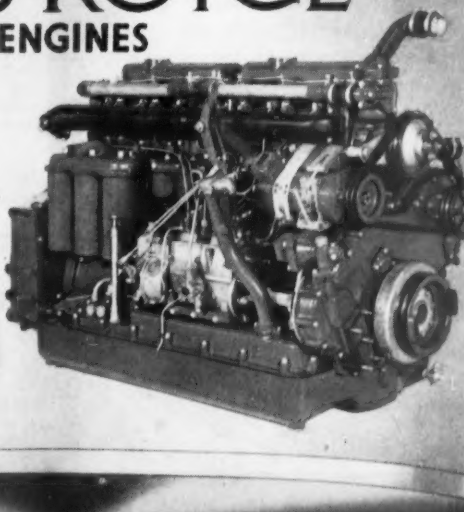

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SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order, 1952

AUTOMOBILE Body Draughting. Section Leader required. Must be able to take charge of body layout and detailing. Experience of production type bodies from jigs and tools essential. Excellent prospects to suitable applicant. Write giving details of age, experience, etc., to Personnel Manager, Carbodies Limited, Holyhead Road, Coventry. [4768

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CANDIDATES for this post must be technically qualified, with the ability and experience to discuss flexible drives in all branches of engineering. Application, which will be treated in confidence, should state age, qualification, experience and full details of past and present position. Box 2717, c/o Automobile Engineer. [4769

WELL qualified Engineers required for Sales Staff of Midland Engineering Company manufacturing specialized products. Engineering degree or equivalent desirable, combined with the ability to negotiate at technical and commercial executive level in such spheres as automotive, railway, aircraft and general engineering. Applications, which will be treated in confidence, should provide references and a detailed account of past activities, qualifications, personal data and present appointment. Box 2718, c/o Automobile Engineer. [4770

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Capital available £20,000.
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K.L.G. SPARKING PLUGS Ltd., London, S.W.15, require an Assistant Development Engineer for their Automotive Ignition Department. Applicants should possess B.Sc., Higher National Certificate or similar qualification, have had both theoretical and practical experience of I.C. engine and electrical laboratory work, including design; they should be aged 28-35 years, be able to show evidence of personal initiative, original thought and ability to work without direct supervision. Write in first instance giving information in line with above requirements and quoting salary expected; mark envelope "AADE." [4772

ENGINE BENCH TESTERS.

VACANCIES exist in the Experimental Division of Vauxhall Motors Limited, Luton, for men with experience of engine testing, on electrical or hydraulic dynamometers, for development work on car and commercial truck engines.

ABILITY to prepare, modify and set up engines, including instrumentation, on test bed and to produce accurate test reports is essential.

APPLICATIONS in writing, giving full details of experience, technical training, date of birth, etc., to Route 215, Vauxhall Motors Limited, Luton, Beds. [4774

MOTOR Vehicle Chassis Engineer required with experienced knowledge of steering geometry. Must be prepared to visit the U.S.A. Please give, in confidence, qualifications, experience and salary required to Technical Director, Jonas Woodhead & Sons Ltd., Kirkstall Road, Leeds 4, marking the envelope "Personal." [4775

JOSEPH LUCAS Ltd. require a young Automobile Engineer for the coldroom section of their Proving Laboratory. Duties include investigations into the starting of I.C. engines under low temperature conditions and other allied problems. Applicants should have H.N.C. in mechanical engineering and experience in the testing of automobile engines is desirable. Please reply stating qualifications, experience and age to Personnel Manager, Joseph Lucas Ltd., Great King Street, Birmingham, quoting reference PM/D/88. [4758

DESIGNERS. Four first class Designers required by leading manufacturers of Vehicle Component Assemblies and Servo Brake Equipment. Previous experience in light mechanical engineering an advantage and good salary will be paid for the right type of men. The Company is rapidly expanding and there are good prospects, also a non-contributory pension scheme after initial period of service. Housing and cost of living are reasonable in this area. Apply in writing giving full particulars to Chief Engineer, Clayton Dewandre Co. Ltd., Lincoln. [4771

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HARDFACING by Welding. By M. Riddihough, M.Met., A.R.I.C., F.I.M. A practical manual covering every stage of the process—design of components, choice of hardfacing alloy and technique of depositing, inspection and finishing methods. 8s. 6d. net from all booksellers. 8s. 10d. by post from The Publishing Dept., Dorset House, Stamford Street, London, S.E.1.

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Pressure die castings in aluminium alloy form the major body components of the "Flamemaster" hand torch illustrated here by courtesy of Messrs. Chance Bros. Ltd. Our customer says: "The aluminium die castings which we have obtained from you for use on this product have proved entirely satisfactory, and are a great improvement on the previous covers. It is in fact true to say that they save us considerable assembly cost due to their accuracy of fit and excellent finish." *Extract of letter from Messrs. Chance Brothers Ltd., Smethwick, Birmingham 40.*

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